AGRICULTURAL ENGINEERING

Published monthly by the American Society of Agricultural Engineers

at the headquarters of the Society

54 North Avenue, Mount Clemens, Michigan, U. S. A.

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to the members of the Society, $2.00 a year, 20 cents a copy. Postage to Canada, 50 cents additional; to foreign countries, $1.00 additional. Entered as second-class matter, November 7, 1923 at the post office at Mt. Clemens, Michigan, under Act of August 24, 1912. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title "Agricultural Engineering" is registered in the U. S. Patent Office.

F. W. IVES, President RAYMOND OLNEY, Secretary-Treasurer

Vol. 5 JULY, 1924 No. 7

CONTENTS

EDITORIALS....147

PRESIDENT IVES PASSES AWAY....148

THE PRESIDENT'S ANNUAL ADDRESS....149
By S. H. McCrory

GARDEN MACHINERY DEMONSTRATIONS....150
By E. R. Gross

ELECTRICITY IN AGRICULTURE ABROAD....151
By R. A. Lundquist

THE RELATION OF FARM ANIMALS TO PROPER VENTILATION OF BARNS....155
By M. A. R. Kelley

RESEARCH METHODS IN AGRICULTURAL ENGINEERING....158

—Soil Erosion as a Research Problem
By W. H. McPheeters

—Research in Agricultural Engineering—1923
By R. W. Trullinger

SURVEY OF AGRICULTURAL ENGINEERING PROGRESS....163

A. S. A. E. AND RELATED ENGINEERING ACTIVITIES....164

Statements of facts or opinions advanced in original articles, papers or discussions are not sponsored by the Society as a body. Original articles, papers, discussions and reports may be reprinted from this publication provided proper credit is given.

The Object and Scope of A. S. A. E. Activities

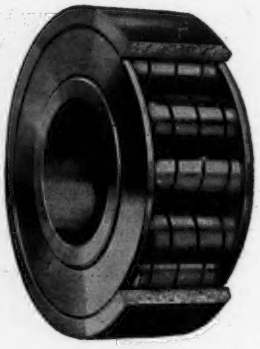
THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.
(b) Farm Structures—buildings and other structures and related equipment.
(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.
(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.
(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.

Member American Engineering Council



What you want most in bearings you will find in Hyatt Roller Bearings. Sturdiness, capacity, durability, and all backed by a record of dependable service established over a third of a century.

HYATT ROLLER BEARING CO.

NEWARK DETROIT CHICAGO SAN FRANCISCO

Buffalo Minneapolis Philadelphia
Pittsburgh Cleveland Milwaukee
Huntington Worcester

HYATT

ROLLER BEARINGS

AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, M. E., A. E., Editor

Vol. 5 JULY, 1924 No. 7

EDITORIALS

THE passing of Fred. W. Ives will bring a feeling of deepest regret to all agricultural engineers who knew him personally or by reputation. He had just assumed office as the eighteenth president of the American Society of Agricultural Engineers, an honor to which he was richly entitled, and because of his ability and enthusiasm the Society looked forward to a year of outstanding growth and achievement under his leadership. However, it is not alone because we will be deprived of the priviledge of having him as our president and enjoying the benefits of his rare good judgment and counsel in Society affairs that we will miss him; it is more because of Fred Ives the man—sincere, honest, lovable, capable, of high ideals and an irreproachable character—a man whom we loved and admired because of his sterling worth and shining example.

Fred. W. Ives

In Professor Ives the Society has lost one of its best and most loyal members and workers, and the profession of agricultural engineering one of its finest and foremost leaders. Still a young man he had achieved outstanding recognition in his profession. His contribution to the advancement of agricultural engineering education and to other phases of the development of the profession stands as a most fitting monument to his memory. His life and work are an example after which any well might pattern.

Though he has left us and we deeply mourn the untimeliness of his departure, Fred Ives still lives on, rising to greater spiritual heights and to larger achievements in the Father's vineyard.

WHILE actually in process for a decade and a half, it has been generally recognized only a comparatively short time that a gradual though certain transition from muscle power to mechanical power in agriculture has been taking place. Transportation and the manufacturing industries are a long way along in this transition process, and there is no reason to believe that agriculture will not follow much the same course.

Farm Power Trend

Farm leaders are agreed that the salvation of the farming business, from a financial standpoint, is not in higher prices for farm products but in lower production costs. If this means anything it means the more extensive, more efficient application of mechanical power to agricultural processes. It means also the wider use of labor-saving machinery and mechanical equipment of all kinds; and what is quite as essential is a radical improvement in farming methods and processes.

The credit for the advance that has already been made along these lines belongs to the agricultural engineers, of both manufacturing and educational institutions; they have pioneered the transition, and they are a unit in believing it a logical and necessary development.

The American Society of Agriciultural Engineers as the representative of the agricultural-engineering profession has from its earliest history unqualifedly promoted the advancement of mechanical power in agriculture. However, to leave no doubt as to its position as an organiization, at its last annual meeting at Lincoln, Nebraska, the Society adopted the following significant resolution:

WHEREAS, in view of the results of the investigations carried on by educational institutions concerning the utilization of power in agriculture and reported to the American Society of Agricultural Engineers, and

WHEREAS, the Society recognizes the transition in agricultural power requirements, and

WHEREAS, in view of the unreliable and misleading information frequently disseminated regarding specific forms of power used on the farm, therefore, be it

RESOLVED that the Society go on record as impartially favoring the use of that type of power which best meets the user's needs and conditions, and be it further

RESOLVED that we recognize the economic trend toward the more complete use of mechanical power in agriculture, and that we recommend more extensive, scientific research on this subject.

"FINANCIAL profit is the aim and object of all farming operations. Profit is the margin between cost of production and net selling price and may be increased by lowering the cost of production as well as by securing higher prices. Moreover, the farmer has direct control over his production costs.

A Sign of the Times

"The cost of labor is a large item in producing farm commodities. Under present conditions, to reduce the cost of labor it is necessary to make it more efficient my enabling each man to accomplish a greater amount of work in a given time. Usually this means providing each man with more efficient tools and machines as farm labor has largely become a matter of utilizing proper implements. A man who can cover ten acres of ground in one day with a large machine clearly does so at a less cost per acre than a man who with a smaller implement covers but five acres.

"The subject of efficient farming machinery is doubly important at this time. Not only are labor costs mounting, but the replacement of much old and worn-out machinery will soon be necessary. Owing to the decreased purchasing power farmers have purchased much less than the usual amount of farm machinery during the past four or five years, which means that replacement needs are accumulating.

"The subject of standardizing farm machinery is one of considerable moment to those who are interested in securing the maximum of efficiency from farm implements. Standardization has been making steady progress throughout the country, and every farmer and associated interest should exert their influence towards furthering this commendable policy."

In the March issue of this journal in an editorial entitled "New Interest in Farm Machinery" we commented on the tendency of the state agricultural colleges and the federal department of agriculture, other than agricultural engineering departments, to break the silence on subjects pertaining to farm machinery; the foregoing paragraphs we have quoted from the foreword of a bulletin just issued by the extension service of the University of Maryland on cutting the cost of farm production with machinery. The statement is signed by the director of the agricultural extension service at that institution, and indicates a true appreciation of the place and importance of machinery in economical farm production—another sign of the times that agricultural engineering is coming into its own.

It should be said in this connection that not the least important factor in agricultural engineering gaining wider recognition is the high character, honesty and sincerity of purpose, and exceptional ability of the agricultural engineers themselves.

President Ives Passes Away

FREDERICK WALTER IVES has passed away. This sad new comes as a distinct shock to members of the American Society of Agricultural Engineers, and his loss will be deeply felt by all. He was returning to his home from attending conventions of the American Society of Agricultural Engineers and the Society for the Promotion of Engineering Education when he was seriously injured in a railroad accident near Chicago. He survived the accident only a few days. The funeral was held in York Temple, Columbus, July 7. Funeral services were in charge of the University Lodge F. & A. M. 631. The pall bearers were Profs. G. W. McCuen, Virgil Overholt, and W. P. Miller, of the department of agricultural engineering; Prof H. C. Ramsower, of the agricultural extension department; Prof. Turnbull, of the department of engineering drawing, and Dr. Leist, all of the faculty of the Ohio State University. Dr. W. O. Thompson, president of the university, delivered the eulogy.

Prof. Ives is survived by his wife, Mary A. Ives, and a son and daughter.

Prof. Ives had just assumed office as the eighteenth president of the American Society of Agricultural Engineers and was just returning from the best and most significant convention the Society had ever held. Prospects for the development of the agricultural-engineering profession and the growth of the Society were never brighter. The election of Prof. Ives met with universal satisfaction and his administration during the coming year was looked forward to with genuine pleasure, because Frederick Ives was a man who did things. His loss is most unfortunate and regrettable, not alone because of the service he might have rendered the Society and the profession of agricultural engineering, but more because of our affection for him as a friend and co-worker.

Frederick Walter Ives was born in Wisconsin, November 20, 1884. He graduated from the University of Wisconsin in 1908, with the degree of mechanical engineer.

In 1909 he went to Ohio State University as an instructor in engineering drawing. While serving in that capacity his ability attracted the attention of the college of agriculture, and in 1914 he was made assistant professor of agricultural engineering in charge of farm structures. He entered into his new work with enthusiasm and understanding and was very soon recognized as an authority and a leader in the field. In 1920 he was made head of the department of agricultural engineering, which position he has held since that time.

His thorough fundamental training in the science of engineering combined with his knowledge and appreciation of agricultural problems soon brought him national recognition. In collaboration with Prof. Thomas E. French, he wrote a book entitled "Agricultural Drafting and the Design of Farm Structures," the first of its kind, which has found wide use in many institutions. He had also practically completed manuscript for a 400-page textbook on farm buildings.

Prof. Ives designed and built with his own hands the home in which he lived, and the group of new barns on the farm of the Ohio State University will stand as a lasting memorial to honor him and as a mark of his genius in designing farm buildings.

He was a member of the American Society for the Promotion of Engineering Education and also a member of the Engineers Club of Columbus and of the Society of Sigma Xi.

His interests, however, extended beyond the field of professional duties. He was a staunch supporter of athletics at the University and was chairman of the board of advisors of the University Y. M .C. A. He was a member of Alpha Zeta and Phi Gamma Delta fraternities, active and useful in the affairs of each. He was a member of the University Lodge No. 631 F. & A. M. and of York Chapter and Council. He was also a member of the University Grange No. 1620, Patrons of Husbandry.

FREDERICK W. IVES

In addition to his university duties he has served as contributing editor of "The Ohio Farmer" and "Farm and Fireside." He has also devoted a great deal of time to consulting agricultural engineering work, and at the time of his passing was architect for the Presbyterian Home at Sidney, Ohio. He had developed extensive plans for this home, a part of which under his immidiate supervision is now under construction.

Prof. Ives was elected to membership in the American Society of Agricultural Engineers in 1916, and since that time has been one of the Society's most active and valuable members. He was secretary-treasurer of the Society during 1919 and first vice-president in 1920. He was chiefly responsible for the organization of the college division of the Society and was the first chairman of that division. He has served on many important committees, principally those associated with problems of agricultural-engineering education and farm structures. In 1923 he was elected a member of the Council and also made chairman of the Farm Structures Division. In recognition of his inestimable service to the Society he was elected president to serve during the year 1924-1925.

The Council of the Society has fittingly expressed its sentiments, and likewise the sentiment of every member of the Society, in the following resolution:

"WHEREAS, the Council of the American Society of Agricultural Engineers is conscious of a great loss in the untimely passing of our beloved associate and president, Frederick Walter Ives, and

"WHEREAS, we recognize in him one of the outstanding leaders of our profession—a man of the highest character and ability—and one of the Society's most earnest and unselfish workers, and

"WHEREAS, we sincerely appreciate and are profoundly grateful for the invaluable services he has rendered the Society in various capacities, and the distinct contribution he has made to the advancement of the agricultural-engineering profession, therefore, be it

"RESOLVED that the Council of this Society express its deep sense of loss and regret occasioned by the passing of this loveable and capable friend and fellow member, and be it further

"RESOLVED that the Council extend to the members of Prof. Ives' family and to his associates at Ohio State University its profound sympathy."

The President's Annual Address*

By S. H. McCrory

WE have assembled at the University of Nebraska for the eighteenth annual meeting of the American Society of Agricultural Engineers. Custom has decreed that at each annual meeting your president shall deliver an annual address for the purpose of promoting the art and science of engineering as applied to agriculture. I shall endeavor to comply with that custom.

Agriculture is the foundation upon which all civilization is built. If it fails, the civilization it supports must be swept away, for great manufacturing plants and great cities are dependent upon agriculture to supply the food upon which their workers live. A hundred years ago the farmer was almost independent of the rest of the world, for from his farm he obtained food, clothing, fuel, materials for building and animals for transportation. And the work necessary to convert the various products of the farm into usable form was done largely upon the farm. It was necessary to draw on the world outside his farm for but little.

In the past century our country has changed from an agricultural to an industrial nation. Farming has changed from an industry with simple tools, to one that is equipped with a wide variety of tools and implements. Transportation and communication have developed until the markets of the world are at the door of every farm, for the farmer to buy and sell in. The organization that has been developed to bring this about is exceedingly complex. A farmer in Nebraska sells grain, cattle and hay, and with the proceeds buys an automobile from Detroit, farm machinery from Chicago, oranges from Florida, woolens from New England, tea from China, silk from Japan. A strike in New York or London, a change in tariff regulations in one of the European countries, a tribal war in Asia, or a change in railroad or steamship freight rates may profoundly affect conditions in the markets in which he buys or sells. Economic and engineering problems relating to agriculture have increased in complexity and importance as our industries have developed, and there must be careful consideration of both the economic and engineering phases of every prolem if our engineering is to be sound. There are many phases of this subject which it would be of interest to discuss, but at this time I wish to touch briefly upon land as it affects agriculture, and particularly the agricultural engineer.

Lands are employed for producing crops, livestock and timber. Until recently we have had an ample supply of good land on which to draw for crop lands, and large areas of forested lands on which to draw for timber, and large areas available for grazing. This condition has passed forever; the best of the land suitable for growing crops has been occupied and that which remains has some disadvantage which has been instrumental in preventing its use for crops. In the western states this may have been due to lack of water with which to irrigate, in the middle west or eastern states to stumps, or poor drainage, or to lack of transportation. Whatever the reason it has acted as an economic barrier to prevent the development of these lands. It is one of our functions as engineers to remove these barriers. But before undertaking the development of any such lands the engineering economics controlling the success or failure of the development must have careful, complete and impartial consideration.

Study should first be given to the use to which the land is best adapted, and it should be determined if it is best suited for grazing, for timber, for crops or for some other purpose at this time. Let us assume for the moment that it has been decided that it can most profitably be made available for crops. What improvements then are necessary before it can be tilled? If it is to be irrigated, can an ample supply of water be made available and at what cost? Will drainage be needed to prevent the land becoming water-logged and alkaline? How much will it cost to level the land and prepare it for irrigation? What crops can be grown on the land? How large a farm unit will the farmer need to be self-supporting? How much will the cost of operating and maintaining the project each year be? And, finally, to make a balance sheet and to say that at this time the cost of the development is so much, the probable income so much and the project does not offer the prospective settler a fair chance to succeed. Such scrutiny should be applied to all projects that involve the reclamation of new lands, whether by irrigation, drainage or clearing of stumps; and all projects which, when impartially studied, do not afford the competent settler an opportunity to make a good living should be deferred.

The continuance of our timber supply should be a matter of concern to all engineers. Our forest area has been reduced to about 469 million acres, of which only about 138 million acres are virgin forest. The remainder consists of 114 million acres of second growth forests of saw timber size, 136 million acres of second growth timber below saw timber size, and 81 million acres of devasted and non-restocking forest lands. Of the total area only 252 million acres are rated as saw timber.

At the present time we are using about 234 cubic feet of timber annually per capita, and the annual rate of growth in our forests is 24 feet per capita. At the present time we are using about 9.3 million acres per year. The present rate of consumption, it continued, will consume our forested areas in from 5 to 6 decades. Rising prices will no doubt tend to check the rate of consumption to a certain extent. Economies in the use of timber must be effected and other materials substituted where possible. A definite forest policy will be augmented as much as possible. There are approximately 200 million acres of cut-over lands in the United States, a large part of whic his potential crop land. If the timber on these lands was protected from fire and hogs a considerable supply could be grown on these lands before they are needed for agriculture. It is doubtful if at present we are clearing as much as 500,000 acres of cut-over land per year. It may be thought that we can import timber, but timber is bulky and the supplies of desirable timber are largely remote from the United States, even if our tariff policy permitted importation. In the past and at present the principal material used on farm buildings has been timber, and it is a matter of importance to agricultural engineers that an ample supply of timber be provided. I believe that the American Society of Agricultural Engineers could well afford to give increased attention to the forest policies of the United States as they affect agriculture.

Much of the increased production that will be necessary as our population increases can be secured by increasing production on lands now uncultivated.

Better and more thorough methods of tillage will undoubtedly increase production. But if we are to do this it is necessary either to use more labor and machinery or devise new machinery for doing the same work more rapidly and economically. From 1850 to date we have increased our production per worker about three-fold, largely by the development and use of new machinery. Is not one of our most important jobs as agricultural engineers to make the individual worker still more efficient by applying more fully the art and science of engineering to agriculture in order that the farmers of the country shall be more prosperous and able to maintain the American standard of living, to which we are accustomed.

The interval between our annual meetings has been

*Eighteenth annual meeting.

short due to the change in the date of meeting, but notwithstanding this there has been much valuable work accomplished, as you will more fully appreciate as you listen to the reports from the various committees. There has been increasing recognition of the importance of the work of the Society. As an example of this, I might cite the request from the American Engineering Council that two members of the Society be appointed to serve on a committee to consider the problems involved in the development of Muscle Shoals, the appointment of which was requested by Senator Norris.

After three years' service as the representative of the Society on the council of American Engineering Council, I have concluded that where there is only one representative from a society, that this society can be most effectively represented on the council by the president of the society. As the president, from his position, is in closer touch with the work and interests of the Society than anyone else can be, I recommend that from this date on the President serve as the member of the American Engineering Council from the American Society of Agricultural Engineers and that the Council take steps to so amend the constitution as to make such service a part of the President's duties.

One of the notable developments in the work of the Society during the year, has been the organization of a contact committee from the College Division of the Society to work with a similar committee from the National Association of Farm Equipment Manufacturers on problems of mutual interest. These committees have already started important work and in the future their work should be of increasing value to both organizations.

There has been an increasing interest in the application of electricity to agriculture during the year. Many important investigations have been undertaken or are being planned. This work offers a new field for agricultural engineering and the Society should, through it proper committees, give attention to the training that the men who expect to enter this field should have. It should also give careful consideration to the organization of new committees to study the various phases of this work.

Radio has captured the world. It will not be long before the radio set in the home will be considered as necessary as the telephone. I think that the Society might advantageously organize a committee to study the many problems involved in the use of radio and we might make use of the columns of the Society's journal to disseminate quickly the information that they obtain.

Garden Machinery Demonstrations

By E. R. Gross

IF it were possible to plant and harvest a crop on the same day, it would have been done at demonstrations held in six vegetable sections of New Jersey the week of April 21 to 26. Vegetable growers came from miles around each of the centers to see the latest mechanical devices to aid in the production of good vegetables. Practically every machine needed in preparing the seedbed, planting, cultivating, harvesting and marketing a crop was at hand and at work. There were tractors, plows, disks and harrows to prepare a seedbed. There were drills, seeders, fertilizer distributors, and plant setters. In one part of the demonstration plot, rows of rye previously sown were being cultivated by hand and by tractor. There were irrigation systems to water the dry soil. Insects and disease would have no chance if all farms were equipped with dusters and sprayers shown. Various materials for dusting and spraying were also shown. And finally when the crop was ready for market there were baskets and crates, standard containers, to carry the fruit to market. Also a tying machine to make neat bunches of radishes, asparagus, onions, and the like was shown. One move of the lever neatly tied the bunches for market.

Labor-saving farm equipment has increased the farmer's production at least five times since the days of hand methods about 75 years ago. The growing of vegetables still involves too much hand labor. Hence the great interest in this exhibit of machines suited for vegetable growing. It is a very conservative estimate today that 3000 vegetable growers visited these meetings. In addition to the garden machines electric lighting plants and water systems were on display. That the interest was genuine and that the machines performed to the satisfaction of the visitors is proved by the fact that all exhibitors made sales. Dealers were also established by companies not previously represented in the territory. Altogether everyone was pleased with results obtained by this exposition of labor-saving vegetable garden machinery organized and conducted by the extension service of New Jersey Agricultural College of New Brunswick. In immediate charge of the work were C. H. Nissley, specialist in vegetable gardening, and E. R. Gross, professor of rural engineering.

There were nine garden tractors on exhibition. Rye had been sowed in rows of varying widths so that some was suitable for each machine. Thus while machines have a range of uses each found its outstanding qualities at a particular job. Some tractors were large and powerful enough for plowing, disking and deep cultivating for larger crops in wider rows and very small crops, for the very first cultivation which so commonly must be done by hand. Some also had auxiliary attachments such as lawn mowers. Some were made to straddle rows and some to

(Continued on page 157)

THE NEW JERSEY GARDEN MACHINERY DEMONSTRATION

(Left) A line-up of the garden tractor entries at the New Jersey demonstration. (Right) General view of a demonstration field

Electricity in Agriculture Abroad*

By R. A. Lundquist

Chief, Electrical Equipment Division, U. S. Department of Commerce

IN all those countries which we regard as having a relatively high standard of living, there has for a number of years been much effort made to substitute power, in some form or other, for human effort wherever possible, so as to increase the productive efficiency of the individual farmer and at the same time to eliminate the drudgery which from time immemorial has accompanied agriculture. Naturally, the trend of late has been toward the use of electricity for this purpose, in view of its flexibility, its ease of application for the work in which it is employed, in the earlier stages of this new development, and its ready conversion into either light, heat or power.

While the desire to employ electricity in agriculture has been general throughout most of the occidental nations, the activity has been most marked in some of the older countries such as Germany, Sweden, France, Denmark, Holland and England, with a growing interest displayed in some of the British dominions such as New Zealand.

In making a survey of conditions abroad in preparation for this paper, an attempt has been made to secure definite and concise information on the state of development in each of these countries, and also specific operating figures, but it has been possible to obtain only a limited amount of such data, because, while there is in most instances considerable development in localized areas, few countries have as yet available comprehensive results from electric operation throughout rural areas under normal economic conditions.

In studying the question, an attempt has been made first to develop information as to the general economic situation, the size of farms to which electrical operation is applied, the character of crops, and something as to the purchasing ability of the rural population. There was also sought information as to the present electrical development in agricultural districts, the present use of power, either mechanical or electrical, the comprehensiveness of the development up to the present, what it costs the farmer, and how it is financed. Then an attempt was made to bring out the use to which electricity was put on farms in the different countries, with comments on the specific types of implements and machinery, which are employed on electrified farms; the question of cooperative buying of electrical equipment by groups of farmers was also looked into. Lastly, questions were asked as to the portion of the agricultural area of the country, throughout which electric service was at present available, and the number of farms that were taking advantage of the opportunity to secure such service. Economic gains that might result from a broad application of electricity to agriculture were also considered.

The Progress Made in Sweden

The following is a review of the information that has up to the time of writing been received in response to inquiries of foreign offices of the U. S. Department of Commerce, with the addition of such general data as was already available.

Actuated by the pressure of war conditions, Sweden has made considerable progress in the use of electricity in agriculture This has no doubt to some extent been possible because of the fact that the standard of living in Sweden is higher than that of most countries we regard as foreign, and because, in addition, it has an abundance of water power resources within reasonable distance from areas to be served.

It is reported that out of approximately 9,500,000 acres of cultivated land in Sweden, 40 per cent is reasonably well covered by electric transmission lines, so that such districts can avail themselves of service. The bulk of the holdings average between 5 and 50 acres and are operated by the owners in the majority of cases. Farm houses are located on individual farms in most cases, much as in this country, though on account of the smaller average holdings they are ofentimes reasonably close together.

While under war time conditions, farmers were readily able to meet the construction and operating costs, incidental to the use of electricity on their farms, there has been during recent years much complaint of the burden resulting from charges based on war time construction costs. Under normal construction conditions, however, it may be said that the farmers are to a large extent financially able to make use of electricity at fair rates.

The bulk of power used on farms is generated from water power and the government's system alone is estimated to supply approximately one-third of the rural areas that have electric service available. Fuel costs are higher than the average throughout Europe, since the country has practicaly no coal and oil resources. Gasoline at the present time costs approximately 31 to 33 cents per U. S. gallon.

Rural electric service in Sweden is generally handled by local cooperative distribution societies, and it is customary for the government and private companies to help organize such associations, and to assist them to get on an operating basis. Power is sold to them at 1,500 or 3,000 volts, and they take over entirely the distribution to individual consumers, who may be served either by running a 1,500 or 3,000-volt line to each farm establishment, putting in an individual transformer there, or a transformer may be used in common by several close lying farms, with service lines operating at 127/220 or 220/380 volts extended to the various consumers.

Bases of Charges for Service

Charges for rural electric service in Sweden are made up of a fixed sum, developed as a unit per share held in the distribution society, plus a nominal charge per kilowatt-hour, frequently running from 10 to 15 ore, (2.7 to 4 cents). The charges are usually worked out at so much per hectare, since the number of shares in any distribution association is generally equal to the number of hectares of land cultivated by members, each member taking a share for each hectare of land cultivated, (or 1 share for each two lamps, if not farming). Naturally the actual costs per hectare vary considerably, but one so-called average figure of Kr. 16.30 per hectare ($1.77 per acre) per year was given for the use of 25 kilowatt-hours per annum per hectare.

Electricity is used by farms for lighting, milking, pumping, churning, cream separation, feed grinding, grain cleaning, chaff cutting and threshing. Many attempts have been made to apply electricity to plowing and some degree of success has been attained. Great claims are being made at present of the efficiency attained by an electric tractor supplied by a special flexible cable from the edge of the field to a trolley pole on the tractor. It cannot be said, however, that electric plowing is yet on a commercial basis by any method.

There does not appear to be any organized means whereby a farmer is given financial assistance in buying the electrical equipment he may need for his individual installation, but there is some cooperative purchasing of threshing machine motors.

For small work around the farm a one horsepower motor on skids is very common and probably the bulk of the motors in use throughout the country run from 1 to 5 horsepower. For threshing, the motors run from 5 to 25 horsepower, the smaller size being employed to drive

*Eighteenth annual meeting paper.

a special type of small thresher. The larger threshing machine motors are operated at the primary voltage as a rule and with their control equipment, necessary switches, etc., are housed in a special power wagon and hauled about as needed. Connection is made at a line pole (on which are provided special switch clips) by means of a long wooden rod carrying contact points, to which the supply cable for the power wagon is connected.

Most of the farms that use electricity purchase it from power distribution networks as outlined, the number of engine-driven electric generating sets being very small. Apparently there is a tendency to carry processes a very little farther on the larger electrified farms than is true in the case of smaller farms that do not have electric service, but this is confined largely to feed grinding and grain cleaning, etc. As yet there is no apparent decentralization of industry as a result of electricity becoming available throughout rural districts and there appears to be no growth of household industries as a result of electricity becoming available on farms.

In Germany the use of electricity in agriculture, as well as many other comprehensive economic developments of the country, has been brought to a temporary standstill by existing financial conditions. In Germany there does not appear to be as well developed an employment of electricity in agriculture as in Sweden, but there are large areas over which electric service is available. There is little information as to the average size of the farm in what we are terming an electrified section. As regards agriculture in general, according to the last census statistics, approximately 60 per cent of the farms were under 5 acres and 90 to 95 per cent were 50 acres or less. Electricity is not used in any one group area more than in another, which might be expected in view of the fact that, as has been stated, the electrification is not widespread.

As a rule, the farmers generally own the land which they cultivate and, while the farm houses in the case of large holdings are somewhat scattered, there is considerable grouping of farm houses where the holdings are small. Under normal economic conditions the German farmer is financially able to use electricity to the extent needed, but at present conditions are unfavorable to any development along these lines.

Germany Uses Fuel-Burning Plants

It is said that about 90 per cent of the power used on estates and farms is generated by fuel-burning plants, water power being available only in southern Germany, as a rule. There has not been in Germany the same governmental participation in the development of power resources that exists in Sweden. At least 50 per cent of the existing power plants are privately owned. Coal costs are normally reasonable from an American viewpoint, running from $4.00 to $4.40 per ton for steam coal at mine, while gasoline costs 20 to 22 cents per gallon at retail at the present time, kerosene 10 cents a gallon, and industrial alcohol 24 cents per gallon.

As regards the rates for electricity paid by farmers, it is estimated by Prof. Fisher, of the agricultural university of Berlin, that the average cost per kilowatt-hour is now between 10 and 12 cents, or about 10 to 20 per cent above the pre-war rate. Farm consumers of electricity are not given any concessions over city consumers.

As in Sweden, there are a great many cooperative power socities which buy electric energy in bulk and distribute it to the members of the association within the area served by them. The government does not advance money to these cooperative distributing societies, but prior to the war they were indirectly subsidized by being able to secure cheaper credit than was given other organizations of equal financial standing. It is expected that this practice will be resumed as soon as feasible. The distribution society owns all of the electrical equipment from the point where power is delivered to it, at the distribution voltage, to the point where services are taken off to individual buildings.

It is difficult to say for just what purposes an average farmer uses electricity. It is employed in threshing, chaff cutting, milking, churning, wood sawing and the lifting of hay and grain. Very little power is used in plowing, but experiments have been conducted in the curing of hay and ensilage.

The motors most commonly found on German farms are rated at about 1½ horsepower. Some as small as one-eighth horsepower are found in connection with small blowers for cleaning seed grain. Individual farmers are not in any way aided in buying electrical equipment.

Prof. Fisher, quoted in a previous paragraph, estimates that about 20 kilowatt-hours per year are consumed for each hectare of land in the electrified sections from which the average cost of farms of various sizes can be computed, taking an average rate of 10 to 12 cents per kilowatt-hour.

As a rule, electrical equipment is not bought by a group of farmers for common use, though in some cases communities have purchased jointly large motor units for operating threshing machines. As a rule, however, it is considered impracticable, as the individuals of a group would all need a machine at the same time in most cases.

Electric service is available fairly generally throughout Germany and it is estimated by Dr. Walter Strauss, consulting engineer of Berlin, that at the present time about 66 per cent of German farmers use electricity, which figure I feel is meant to state that percentage of the total farmers in an electrified area who use the electric service, and not indicate the ratio for the country as a whole.

Processes on electrified farms are not carried any farther than on those not using electricity, and there is no apparent tendency toward the decentralization of industry as a result of power facilities in rural districts. Farm labor is drifting toward industrial cities as in other European countries, but an aggravated food shortage, as well as unemployment, has checked the movement considerably.

Progress Is Slow in France

In France, apparently, electric service has not been extended as broadly as in the countries already discussed. It is said that the farms which are electrified run from 100 to 800 acres in area, though considering the country as a whole, possibly 75 per cent of the farms in France are 12½ acres or less in area. The rural sections which might be classed as electrified at the present time are largely in the north of France, and the principal crops produced are cereals, beets and potatoes.

The large majority of farms are owned by those who cultivate them, and the farm buildings are generally well scattered in those districts which are now electrified. In the case of small farms, however, the owners group their houses close together in small hamlets, in many cases at some distance from the fields.

The majority of French farmers are prosperous and, where the size of their property warrants it, are financially able to make use of electricity at existing rates.

Since the rural districts that are at present being best served electrically, are in the northeastern section of France and in the Paris region, the power used is generated by fuel-burning plants. This situation is due to the fact that the size of the farms and the character of the crops in these areas have made it possible to use electric power whereas, where water power is available, conditions oftentimes do not favor the employment of power.

The French government itself has not and does not contemplate constructing electric power systems to give electric service to farmers. It has, however, participated in linking together many of the large power generating stations, and it has also provided for loans to distribution associations for the building of secondary lines to serve rural areas. Where rural electrification has been undertaken, it has been carried out by cooperative distribution societies, which financed and operated the systems, borrowing money from the government for a portion of their funds. Power is bought in bulk.

Fuel costs are considered to be very high in France at the present time. Coal is 200 to 300 francs per metric ton ($8.50 to $12.75 per short ton), gasoline is 137 francs per hectolitre (30 cents per U. S. gallon), kerosene is 108 to 111 francs per hectolitre (23 cents per U. S. gallon), and industrial alcohol is 376 francs per hectolitre (80 cents per U. S. gallon), all values converted at average exchange rates for March, 1924.

The rates for electricity on farms run from 1 to 1½ francs per kilowatt-hour for low tension current. Rates for high tension current average somewhat less than one-half franc per kilowatt-hour. Farm consumers are not given any concessions over city consumers.

The main uses to which electricity is put in the rural districts are lighting and the operation of presses, dairy machinery and pumps. A few threshers are electrically operated but steam and gasoline engines are more commonly employed. With the development of community ownership and leasing of electrical farm equipment it is thought that the number of electrically driven threshers will increase. A 15 horsepower motor is ample for the largest threshers used, i. e., those handling about 400 bushels of grain in a ten-hour day. Smaller machines requiring 6 to 10 horsepower are also common.

On electrified farms in general the motors used run from 1 to 10 horsepower, the only exceptions being in the case of larger threshing motors. As a rule, motors are transportable, being placed on a light truck or farm wagon. In the wine and dairy districts the motors usually range from 1 to 5 horsepower. Individual farmers are apparently not assisted in any way in the purchase of electrical equipment needed by them.

Electric plowing is said to have been successful in the few cases in which it has been tried. It was claimed that electric plowing was deeper than by other methods. However, the outlook is not bright, since the first cost for such equipment is too heavy for the average farmer, in view of the small acreage owned by him. The limited use of engine-driven tractors in France is pointed out as an indication of the difficulty that will be experienced in the development of electric plowing. Considerable experimental work has been done by tractors driven by gas producer engines employing wood or charcoal as fuel.

While there have been a number of instances where electrical equipment has been purchased by a group of farmers in a community, it is said that the farm owners prefer to purchase individually the electrical equipment which they need.

At the present time practically all the electric power developed in France is distributed among 6,000 of the 36,000 communes and almost all of the communes served with electricity can be classed as urban. With the carrying out of the program for the distribution of electrical power throughout the country, it is thought that almost all of the regions containing farms of 100 acres or over will be able to be supplied with current.

The number of properties in France electrified by means of small plants, either fuel-burning or hydraulic, does not exceed 500, and the number of farms served with current by power lines is much smaller. No accurate statistics, however, are available on this question.

THE SMILES THAT CAME WITH ELECTRICITY

(Left) Cooking the first meal by electricity from the experimental rural electric line (Project No. 17) at the farm home of B. I. Melin, near Red Wing, Minnesota. (Right) This is Mr. Cady watching electricity drive his cream separator; he was the first customer to receive electric service on Project No. 17

As only the larger farms, with financially strong proprietors, are electrified it is not possible to state whether it is owing to the use of electricity or not, that processes on these properties are carried on farther than on the smaller farms. This would seem to be the natural result of a more economic grouping of acreage, regardless of the kind of power employed.

As previously stated, the tendency in France during a number of years past has been for farm labor to drift to the industrial cities, and although the electrification of the country districts has not been carried on to a sufficient extent to permit of any statement as to its effect on the decentralization of industry and the growth of household industries, there is much confidence that these will be the natural results of the rural electrification that is planned.

The application of electricity to agriculture in Great Britain has not been very widespread, but some very thorough experimental work has been carried on, notably by Mr. R. Borlase Matthews. Many of the large estates maintain electric generating equipment or buy power from nearby towns, but it cannot be said that there is any real electrified rural section in Great Britain. This inactivity in the use of electricity on the farms in England does not appear to be a question of purchasing power, though, of course, many power applications which are practicable in the case of large estates could not be made generally, since farms are rather small and will not warrant heavy investment in machinery.

Cost of Service High in England

From a knowledge of electrical conditions in England, I would judge that municipal ownership of existing central stations and a prejudice against overhead electric lines contribute largely to the situation. Naturally, a municipal plant has limited power outside its corporation limits, so that there has not been a reaching out for business by central station systems as has been the case in other countries. Again, where the system is underground to a large extent and there are numerous restrictions handicapping the building of overhead lines, the cost of extending service to scattered consumers is so high that the rates that must be charged do not meet the competition of other forms of power.

Most of the power available in England is generated from fuel-burning plants, and coal is relatively cheap in most sections. There is no movement by the government toward the development of national power systems, but a governmental body known as the Electricity Commission is working on comprehensive plans to gradually build up series of large capacity power systems in lieu of the scattered small capacity stations now serving England. As an indication of the electrical development in Great Britain today, it is said that there are a number of towns of ten thousand which do not as yet have electric service. This governmental board contemplates helping the farmer in working out power supply systems for rural areas, but the help would be rather indirect insofar as the present plans indicate.

There has been so little development in the use of electricity in rural areas that no general figures can be given for rates, though it is said some power supply has been given at rates as low as two cents per kilowatt-hour, with light at twelve to sixteen cents per kilowatt-hour. It is stated that the actual rate for electricity has not been a factor of prime importance but that the high installation cost for employing electricity has been the real deterrent. Electricity installations are too few to generalize in regard to comparative rates, but it is thought that rural consumers frequently are required to pay more than city consumers. As yet no cooperative distribution societies have been organized in England to take over the financing of distribution systems in specific areas, as is common in other countries.

Where electric installations have been tried, power has been used for practically all possible purposes. Experiments with electric plowing have been along the lines of

the Fowler system or variations thereof, but there does not appear to be any real commercial development of this application.

While there is only a limited development of electric service in rural districts through power lines, there have been a great many farm lighting plants sold, though probably the bulk of these are used for the lighting of country estates rather than for utilization by what we call "dirt farmers." It has recently been estimated that there are at least 15,000 to 20,000 individual home lighting plants in use in the United Kingdom.

There is some apparent tendency toward decentralization, but this can hardly be said to be the result of electricity becoming available and, as a matter of fact, farm labor is drifting to industrial cities. As regards the possible development of household industries, as a result of electricity being available, no such efforts can be commented on at the present time because of the isolated instances in which service is given in rural areas.

Probably no country has embarked on a more ambitious scheme for making electricity available to its people than has New Zealand. In both the north island and the south island a single large interconnected power system has been definitely planned and a certain amount of progress to that end made.

The policy of the government on the whole is to supply power in bulk, leaving distribution and delivery to consumers in the hands of the local authorities. In order that rural districts might be empowered to carry on the distribution of electricity with the same powers as those open to a municipality, the Electric Power Board Act was passed in 1918. This act permits a number of districts to combine for the purpose of electric power distribution and to set up a special electric board to carry out the work, with powers of taxation over the district to be served. So far approximately 30 per cent of the total area of the dominion has been organized under this plan, and more than half of this total either has developed distribution systems at the present time or has such systems under construction. Great developments are hoped for in connection with the rural electrification program under way, since the purchasing power of the people is good and the farm operations permit ready application of electric power, in view of the fact that dairying and sheep raising are the most important phases of agriculture in the Dominion.

New Zealand Has Already Made Good Use of Mechanical Power on Its Farms

There has already been good use made of mechanical power on New Zealand farms. Reports for the fiscal year 1922 state that there were at that time 17,551 internal-combustion engines totalling 57,004 horsepower, 740 steam engines totalling 3,500 horsepower, 934 water wheels totalling 4,379 horsepower, and 1,065 portable or traction engines totalling 6,198 horsepower, against which there were only 778 electric motors totalling 2,581 horsepower. Power is used in New Zealand for chaff cutting, feed grinding, dairying, sheep shearing, and pumping, for the most part, but is in some instances used for innumerable other purposes that present themselves on large and prosperous dairy farms or sheep ranches.

In the Netherlands there is not a great deal of use of electricity in the rural regions. While there is quite a general employment of electricity in urban districts the service has not cammonly been extended outside of cities. There is, therefore, no district that could be called really electrified.

Farms average approximately 25 to 30 acres and the principal crops are potatoes, sugar beets, oats, wheat and rye. Fifty-six per cent of the farms are owned by the people cultivating them. Farm houses are generally well scattered, somewhat as in Sweden. It may be said that there are a great many farmers who are financially able to make use of electricity at existing prices, though it is pointed out that the cost in some provinces is quite high in view of the fact that plants are all fuel burning, operating in rather small economic units. Electricity is on the whole higher priced than in most of the other European countries.

There is a tendency toward governmental development of an interconnected electric supply system for the whole country. Commissions have reported on the subject, and under the proposed scheme the government would generate the current and transmit it at high tension to a certain number of main distributing points, from which each province would transmit to centers of consumption, where local bodies would take over the secondary distribution to the consumers. Fuel is on the whole somewhat high in Holland, coal at the present time costing about 15 to 18 guilders per metric ton ($5.46 to $6.56 per U. S. ton). Gasoline costs at the present time about 36 cents per U. S. gallon, kerosene 16 cents, and industrial alcohol from 36 to 45 cents.

Finland has followed in the footsteps of Sweden as regards electrification of rural districts, to a considerable extent, and has employed water power for this purpose, though a number of coal burning plants have been installed. Line voltages follow Swedish practice largely, with a tendency toward 6,000 volts as the pressure at which the cooperative societies buy power. Secondary voltages are also oftentimes higher, 231/400 volts being common for the later installations. No information has been received as to specific results obtained in Finland, but it is stated that of the total cultivated area, the extent of electrification approaches that of Sweden.

Sweden and New Zealand Have Most Progress in Using Electricity in Agriculture

No definite reports have been received from Denmark, but from general information regarding its electrical development, it is known that the country is covered by transmission lines practically as thoroughly as are some of our middle western states. It is also known that there has been considerable cooperative employment of the use of electricity somewhat as along the lines followed in Sweden.

Reviewing the situation in the various countries, it would appear that the most comprehensive attempts to give electric service in rural districts have been made in Sweden, though the plans in New Zealand, when they take definite form throughout the country, will result in a very broad development in that dominion. It may be said that Sweden's development was in a way forced by economic conditions obtaining during the war period, whereas in New Zealand the application of electricity throughout the country has been of more normal growth. Germany's development was also largely normal and it may be expected that more wide-spread employment of electricity in rural areas in that country will be made as soon as the monetary situation becomes more stable. The smaller German farmers, since the war, have improved their economic position very markedly, and on the resumption of anywhere near normal conditions will be able to avail themselves of the better standard of living that comes with a broader use of electricity.

The appreciation in England of the fact that that country must have a more general use of electricity throughout its industries, in order to conpete in the markets of the world, will undoubtedly react to broaden the development in rural electrification, since there is an apparent realization of the fact that overhead distribution must be employed to a greater extent if electricity is to be made available to the people at a reasonable rate. With the prejudice against overhead lines broken down to some extent, one of the deterrent factors to rural electrification will be removed. Other countries such as Finland, Norway, Denmark and Holland, the first two with abundant water power resources and the latter two with heavy pastoral production, which permits efficient application of power, will undoubtedly make considerable strides in the application of electricity in agriculture in the coming few years. At least that is the indication, as based on the surveys that we have made in those countries.

Considering the general depreciation in purchasing power throughout Europe and the comparatively high cost of electrical construction work, it may be said that the progress in the application of electricity in agriculture has been reasonably satisfactory.

The Relation of Farm Animals to Proper Ventilation of Barns *

By M. A. R. Kelley

Mem. A. S. A. E. Agricultural Engineer, Division of Agricultural Engineering, U. S. Departm ent of Agriculture

VENTILATION like the weather is a frequent subject of conversation when men get together, and like the weather it is a matter upon which men sometimes disagree. This is not surprising since a review of available literature discloses differences of opinion, prejudice and even lack of knowledge. Even comparatively recent writers still hold to old theories which have been disproved by careful investigators and are no longer accepted by the best informed engineers and physicians. Owing to the fact that a percentage of carbon dioxide has in the past been used as a test of ventilation it has been believed that carbon dioxide is a poison. It has been thought and taught that the ill effects which arise from ill ventilated buildings —from stuffy and crowded rooms—are due to an alteration in the chemical quality of the air.

LeBlanc as far back as 1842 found that an animal could survive exposure to an atmosphere containing 30 per cent of carbon dioxide, provided the oxygen content was 70 per cent, and recover quickly from the depression produced by this mixture. Yet I find in a bulletin of recent issue a statement that "A cow may be poisoned from breathing impure gas. More than 1 per cent of carbon dioxide iis considered fatal to a cow." Dr. Leonard Hill states that "No evidence has yet been brought forth which shows that the chemical quality of the air has anything to do with these ill effects; that apart from the influence of infecting bacteria the ventilation problem is essentially one of temperature, relative humidity, and movement of air. The chemical purity of the air is of minor importance and will be adequately insured by attendance to the essentials."

Many arguments can be advanced to support this assertion, but as the time will not permit of further discussion we will accept it as true. This brings us to the present day basis of ventilation which is essentially the control of temperature and humidity and the maintenance of air circulation.

Present Practice Based on Empirical Formulas

The present practices in the ventilation of barns are based largely on empirical formulas and the best opinion of leading authorities but they are lacking in scientific exactness. More than 40 years ago Prof. F. H. King, of Wisconsin, set forth, in an admirable manner, the principles of what is now known as the King system of ventilation and established standards governing the design of this system. These have served for many years and continue to be useful but the wide diversity of conditions found in modern dairy barns make it necessary to modify these standards according to climatic conditions. A study of climatic conditions in the various states made it evident that the requirements of ventilation in the Dakotas and the New England states were not applicable in Missouri or California and that it was necessary to determine the sections of the United States having approximately the same weather conditions, if ventilating systems were to be properly designed. This has been done, the country being divided into four building zones, and it will aid materially in directing our efforts in developing construction for the various climatic conditions.

It is not necessary to discuss before this society the need of proper ventilation for our domestic farm animals—the cow, horse, hog, and sheep; and we must include poultry. Ventilation may be justified on any of five grounds. Of first importance is the maintenance of the health of the animal, for this in turn has an influence upon the health of the nation; especially is this true with reference to the dairy cow. A strong vigorous body is necessary to combat the attack of disease germs. Tests have been shown that the milk yield is increased both directly and indirectly by proper ventilation. There is a saving of feed from spoilage due to excessive moisture and in some cases decreased consumption. The preservation of barn timbers from mold and rot is important. Last and perhaps not the least worthy of consideration is the prevention of spontaneous combustion due to improper or restricted ventilation of mows. It is not possible here to discuss details of construction, but it is desired to point out the importance of further research in the physiological aspects of the relation of farm animals to ventilation.

Within limits normally compatible with life, warm blooded animals are capable of adapting themselves to changes in the cooling power of atmosphere of their environment and to increase or decrease heat production. In a healthy animal there is a maintenance of equilibrium between the amount of heat produced and heat lost. The body has the power of preserving constantly this equilibrium under a wide range of external conditions.

The external factors affecting body heat loss are temperature, humidity and movement of air. The cutaneous factors affecting heat loss are the rate of heat emission from the skin surface, the excretion of moisture from the surface and the velocity of conduction of heat to the surface.

The Cooling Power of a Breeze

We have all experienced the effect of high temperature combined with high humidity which often occurs during the hot days of July and August. It is on these days that we appreciate the increased cooling power of a slight breeze.

Comfort of body is dependent upon the cooling power of the air which in turn is dependent upon temperature, humidity, and air movement. These factors affect the cutaneous nerve ending which control the production of heat and maintain the balance between the temperature of the skin surface and that of the blood in the deeper tissues. The high temperature of 135° F. which has been experienced in Death Valley of California, would wipe out entire communities in regions of high humidity. If a body is kept in the atmosphere of a temperature approximating that of the body, the rate of cooling or loss of heat is dependent largely upon evaporation. In a region of low humidity this takes place without profuse sweating, but in a damp atmosphere evaporation is greatly reduced. For each degree increase, within certain limits, in the cooling power of the surrounding atmosphere there is a definite increase in the body heat loss which must be made good by the heat regulating mechanism of the body. When kept under adverse conditions, this puts a strain on the heat regulating mechanism of the body and tells on the heart and respiratory organs.

The comfort of the animal is dependent upon air conditions that permit the heat generated in the body to be dissipated without due exercise of the heat regulation mechanism. The loss of heat from the body is continuous by radiation, convection and evaporation, hence it is apparent that anything that interferes with its elimination from the body is accompanied by a rise in the temperature and a feeling of discomfort. It has been found than man is most comfortable when the cooling power of the air is four times the rate of his heat production, which in turn varies with his activity. Prof. Fraser has pointed out that

*Paper presented at the annual meeting of the American Society of Animal Production, Chicago, November, 1923.

it is important that the dairy cow be kept comfortable at all times as its condition affects results at the milk pail and the dollars in the farmers pocket. It is important that the optimum cooling power of the air in the dairy barn be determined in order that provision may be made for the comfort of the dairy cow and the maximum production of milk obtained.

The loss of heat from the body is of course equalized by the production of an equal amount within the body through oxidation of the food material. Rubner states that basal metabolism is proportional to the surface of the skin and is approximately the same for our warm-blooded animals per unit of surface. Vierott estimates the relative loss of heat from the body as follows:

1. Urine and feces, 1.8 per cent.
2. Expired air (warming of air, 3.5 per cent, and vaporization of water from lungs, 7.2 per cent), 10.7 per cent.
3. By evaporation from skin, 14.5 per cent.
4. By radiation and convection from the skin, 73.0 per cent.

Feed energy consumed in body maintenance under adverse conditions of environment is not available for milk production. Therefore, as each of the above factors, with the possible exception of the first, are affected by the environmental conditions, it is desirable that the condition surrounding the animal be controlled by ventilation, that is, the regulation of temperature, humidity and cooling power of the air.

Animals Are Not Greatly Benefited by High Stable Temperatures

The largest part of the heat is lost through the skin and the total loss is in proportion to the total skin area exposed. Dr. C. H. Moulton has proposed a method of determining the proportional relation of the skin area to the weight of a steer. Rousay of France has developed a method by the use of which appears possible to determine the skin area of the horse and possibly other domestic animals. This opens the way for an interesting line of research which gives promise of valuable results.

Most investigators have come to the conclusion that animals are not greatly benefitted by high stable temperatures and too high a value has not been put upon heat and too little on fresh air. Any benefits which may have been derived from high stable temperatures were nullified by the poor conditions of the atmosphere caused by restriction of ventilation in the attempt to keep up the barn temperature. Continual breathing of damp stale air in ill-ventilated stables lowers the vitality of the animal and decreases its power of resistance against the attack of disease germs.

The environmental conditions of the modern dairy cow, whose milk is shipped from 300 to 500 miles, have been greatly changed since the time when the sunny side of a straw stack was expected to furnish both feed and shelter for the family cow and when the milk was used only for home consumption or peddled to the neighbors.

The use of milk products has increased 14 per cent during the past year. McDowell's studies show that cows that freshen during the fall months rank highest in average yearly production of milk and butterfat and in the relation of income to cost of feed. At the time of calving and for a considerable period thereafter it is of great importance that the cow be protected from harmful drafts. As most of our milk is produced in the colder sections of the country, protection of the cows, particularly when fall freshening is the practice, is all the more necessary.

Tests have shown that milk yields are affected by sudden changes of temperature. It is possible to maintain a comfortable temperature in a well-built barn and yet have an appreciable circulation of air. Sudden changes in the temperature are avoided in barns having a well-regulated ventilation system. Good circulation with the consequent dilution of the impurity of the air is the aim of all systems of ventilation, but the comfort of the animals must be considered as well as the purity of the air. How the comfort of the animals is dependent on the cooling power of the air has been pointed out.

It has been shown by tests that it is possible to increase the efficiency of man from 15 to 25 per cent by bettering the conditions of the atmosphere in which he labors. There is evidence that the efficiency of the dairy cow may be increased in a similar manner. Measurements with suitable instruments show that the cooling power of the atmosphere, moving at the rate of one mile per hour, is more than twice as great as that of calm air, four times as great when the wind velocity is nine miles per hour, and that the cooling power of air in a closed room is approximately that of calm air. In calm air, such as that of a stable without ventilation, the heat and moisture given off by the animals is not removed causing stagnation of the atmosphere, increased temperature and increased humidity, a condition which interferes with the normal heat regulation of the animal body. Circulation is therefore essential and the amount of circulation desirable is dependent upon the cooling power of the air.

Ventilation is inseparable from heating. The heat given off by the animal stabled in the barn must be employed in raising the temperature to a comfortable degree and also as a motive power in producing a circulation of air, hence, of the heat generated by the animals, enough must be conserved to insure adequate circulation of the air without lowering the temperature to an uncomfortable degree. A barn cannot be kept warm if the allowance of air space per animal is too great, or if it is but partially filled with stock. Obviously not all the heat produced can be saved and the loss varies according to the construction of the barn and the climatic conditions; nor is it possible to regulate the heat production of the animal to any great degree, hence it becomes evident that a design suited to the climatic conditions in one section of the country may be but partially successful in another section.

It is important that we learn more about the heat production of the various farm animals under different conditions. It is obvious that the cooling power of the atmosphere will not have the same effect on cows and horses, which have a relatively scanty covering of hair, and on hogs whose heat regulating mechanism is different. The difference in effect is unknown nor do we know what condition of environment will produce maximum efficiency of the animal consistent with good health. An illustration from a test made by the author will serve to point out the need of further research with regard to animal heat production.

It is natural to assume that, in heating the room of approximately the same size and having similar exposures, the same amount of heat would be required in each of them to maintain the same temperature or that, the same amount of heat being available for each, the temperature of the two rooms would be the same. Such was not found to be the case in the test of two barns in North Dakota, the best available data being used in estimating the heat production. The two barns were each divided into two sections of approximately the same size, one for horses and the other for cows. For convenience in reference the cow and horse stable of the barn may be designated as A and B, respectively, and of the other barn as C and D.

Comparison of Conditions in Stables A, B, C and D

Stable	Vol. of room Cu. ft.	Ventilation Cu. ft. per min.	Average room temperature degrees F	Total estimated weight of live-stock lbs.	Estimated animal heat B. t. u. per hour
A (cows)	20,690	1,866	44.6	30,075	92,250[1]
B (horses)	18,737	1,755	42.8	28,550	46,300
C (cows)	11,468	1,206	42.6	12,380	48,160
D (horses)	11,081	833	43.4	14,100	23,200

[1]It seems questionable whether the last three digits are of significant value since they are based on estimated weight and average feeding and care are assumed for the animals.

The data given in the table is all of interest, but for the purpose of illustration we are interested mainly in the barn temperatures and the estimated heat production. It will be noticed that although the estimated heat produced in stable B by horses is 50 per cent less than the estimated production of the cows in stable A, yet there is an average difference in temperature of only 1.8 degrees. In comparing C and B an average difference of less than one degree in temperature is found. There was little difference

The proper ventilation of farm barns is an engineering consideration that should not be neglected by the builders

in the weight of the livestock or in other conditions in the two sections of each barn. It would seem that the actual amount of heat given off in each of the two sections of the respective barns was approximately equal since there was very little difference in the temperatures. It would appear that the coefficient of heat production, used in the test and based on the best available data, is much too low for horses. The indications are that the amount of heat given off by the average farm horse and the average cow is more nearly the same than we have been lead to believe in the past. There is great need for further study of the heat production of horses and of other animals and the determination of a more satisfactory coefficient. The data will be of value not only to nutritionists but also to the agricultural engineer who will need it in solving the ventilation problem and in determining the power efficiency of the farm horse.

Armsby and Kriss[1] suggest that the heat supplied by cows theoretically appears to become deficient for the maintenance of a stable temperature of 50 degrees Fahrenheit when the temperature outside is 15 degrees Fahrenheit. They based this calculation upon an assumption of no heat loss through stable walls. Obviously their figure is too low since ventilation tests show that it is possible to maintain a comfortable temperature (45 degrees Fahrenheit) within a well-built barn when the outside temperature is 23 degrees below zero, and this too notwithstanding unavoidable and not negligible heat loss through the walls. The discrepancy shows the need of securing some coefficient which will reconcile the theoretical with the practical.

Ventilation is inseparable from heating; each installation constitutes an individual problem and local conditions must be taken into consideration. The mechanical engineer knows the approximate amount of heat which may be obtained from various kinds of fuel and bases his design and construction on those values. The agricultural engineer needs the assistance of the animal nutritionists in the determination of a satisfactory coefficient of animal heat production.

Some of the problems to be solved are:

1. Determination of the cooling rate of the air best for the comfort of the stock.
2. Determination of the metabolism of the dairy cow in milk under different conditions of temperature, humidity and air circulation.
3. The relation of stable temperature to milk yield.
4. What constitutes good ventilation under various conditions.
5. Determination of skin areas of horses, cows, hogs, sheep, etc.
6. Determination of the moisture production of various animals.
7. Determination of the critical temperature of farm animals; the values now used seem to be too high.

[1] "Some Fundamentals of Stable Ventilation", Journal of Agricultural Research, June 1, 1921.

Garden Machinery Demonstrations

(Continued from page 150)

go between rows. Some were quite high to pass over crops already grown tall. Some had one wheel, some two. Cultivator parts were attached directly to the tractor in some or were carried on a cart in others. Some had steering devices to guide the cultivator separate from the tractor. Some were riding machines, but, very naturally, most garden machines were found especially adapted for furrowing and ridging, and yet did excellent work between rows and in stradding rows. And for the farmer who does not feel the need for a power machine there were hand and horse hoes and cultivators for every crop and every period of the crop's growth. There were seeders and planters hand operated, horse dawn and propelled by the tractors. There were smoothing harrows, sprayers and dusters requiring a two horse team. Potato planters and fertilizer distributors, and the sprinkling system of irrigation was in action with an automatic oscilator to move the spray from side to side so the gardener may sleep while he is watering his crop at night.

Growers who attended one of these demonstrations could not help but profit by what they saw and heard. Visitors not only saw but tried themselves any machines in which they were interested.

Timber Interests to Study Reforestation

WHAT is probably the most far-reaching and significant movement of American lumbermen to investigate private forestry opportunities that has so far been undertaken is the recent announcement by the Forestry Committee of the National Lumber Manufacturers Association to the effect that eight of the largest lumber manufacturing and timber-owning corporations on the Pacific Coast have recided to inaugurate immediately field studies covering representative land and economic conditions in several of the most important Pacific Coast forest-type regions with a view to the introduction of forestry management of their timber holdings. Several hundred thousand acres already selected will receive preliminary examination the first season, after which further extent and detail of the project will be determined in order to guide investigatory work, likely to continue several years.

The Western Forestry and Conservation Association, Portland, Oregon, an organization of timber owners, is directing the project. A dual purpose is provided for by the association's plan. On behalf of all interests alike, study will be made of the condition of cutover lands, methods of their treatment, forest growth and yield possibilities, other possible uses, influence of cutting and brush-disposal methods, etc.; also of economic factors bearing on proposals for the use of forest land resources. It is proposed to extend the movement from year to year as facilities increase or as the tracts are covered, until there is a thorough knowledge of possibilities under varying Pacific Coast conditions.

Research Methods in Agricultural Engineering

Research activities in the agricultural-engineering field are presented under this heading by the Research Committee. Articles dealing purely with the manipulation of research methods and equipment are featured. Members are invited to discuss material presented and offer suggestions on timely topics

Soil Erosion As a Research Problem

By W. H. McPheeters

Assoc. Mem. A. S. A. E. Agricultural Engineering Specialist, Oklahoma A. and M. College

SOIL erosion is one of the biggest problems confronting the farmer of the South today. This applies especially to the state of Oklahoma. The farmer's soil is his capital stock, and if he has to draw on his capital to pay running expenses, he is evidently making no profit. There are two great drains on his capital: One is the depletion of the soil of its fertility by the removal of plant food by the one crop method, and the other is letting the soil wash away.

The protection of the soil from washing is a problem for the agricultural engineer. A great deal of terracing is being done to prevent or check erosion, but not nearly enough. There are also many methods of terracing used. The discussion on terracing at the 1923 annual meeting of the American Society of Agricultural Engineers showed that various agricultural engineers do not agree on many points of terracing. For this reason it is felt that there is room for some real research or investigational work to be done on soil erosion. As far as can be learned, very little research work has ever been done along this line. Of course, each agricultural engineer who has done much terracing has found out certain things that seem to work under his conditions. However, these facts should be proved by experiments, established, and compiled in order that everyone may have the advantage of them and know that he is using the proper method, and not one that he has only heard about.

If research work is undertaken along the line of soil erosion, it should be gone into thoroughly and systematically, for if it is worth doing at all it is worth doing well.

Owing to the fact that the problem of soil erosion is one of the vital problems in Oklahoma ,the writer has given it a great deal of time and thought. Soil erosion has been found to be a many-sided problem and consequently one needing the attention of many agricultural engineers if it is to be investigated thoroughly.

In this article an effort is made to enumerate the phases of soil erosion which seem to need investigation and to outline briefly a few suggestive methods of attacking these problems. These methods may not be applicable for some conditions, but the suggestions, may serve as a nucleus for the development of methods by others.

A statement heard frequently from the farmer is, "The soil is washing much worse the past few years than ever before." There are apparently several reasons for this. In the first place, the soil washes more easily when depleted of its organic matter. Here is an opportunity for some research work to determine to what extent vegetable matter or humus in the soil retards erosion. The second reason for this statement is really an illusion. When the land was first put into cultivation, there was sufficient good soil to grow crops and the farmer did not miss the soil that was moving down by sheet washing. But since this soil is getting so thin that he has none to spare, he misses the soil more from each rain. A third reason for the farmer's statement is the fact that at first water had a tendency to work down the hillside, causing sheet washing, but after each rain its course became more definitely limited to channels. The deeper these channels become, the more numerous and longer are the branch channels that lead into them.

It is rather difficult to determine the exact value of humus in soil erosion on a large scale in the field. It would seem that this can be handled nicely without great expense by the use of minature fields. These fields can be built in a large concrete, metal or wooden box so that the shape, size, etc., can be the same for each sample of soil. The amount of water (put on with spray) can be so regulated as to be the same for each sample.

This method was suggested by Mr. R. W. Trullinger, of the U. S. D. A. Office of Experiment Stations, in his letter of October 25, 1923, to Prof. J. T. McAlister, of Clemson College, South Carolina. This letter stated:

"I believe that the best method of undertaking such a study is to begin with the assumption that the soil itself is the most important factor concerned, and with this as a basis, to learn first as much as possible in the laboratory on a small scale about those soil properties which effect its tendencies to erode under the influences of running water. Such laboratory work will involve a consideration of (1) why and to what extent natural field soils of specific types erode and (2) what modifications of the natural soils, such as liming, green manuring, fertilization, increasing the humus and colloid contents, etc., are effective in reducing the tendency of individual soils to erode to a minimum.

"With a knowledge of the soils of your state which tend to erode, and with the general knowledge gained in the laboratory of the factors causing erosion and influencing its intensity, you should be better fitted to undertake field studies of the washability of soils in large plats using the best methods and expending the least amount of funds.

"Once the field studies of washability of the soils have indicated the maximum amount of erosion which must be cared for from a particular soil type under the worst conditions, with due consideration of and allowance for the possible retarding influences of the different soil treatments mentioned above, you will then be in a position to develop terraces, etc., to meet these conditions for each soil type and environment. The futility of making comprehensive tests of arbitrarily selected types of terraces, etc., without a previous fundamental consideration of the erosive tendencies of the soil itself is thus plainly evident.

"In the preliminary phases of this work I would suggest a close cooperation with a soils chemist who can work with you in the laboratory and give thorough and accurate consideration to those physical and chemical, and possibly biological properties, which influence the washability of the specific soil types of your state which tend to erode. In this connection it would seem quite possible to remove small undisturbed sections of such fiield soils, say, 5 feet square and 4 or 5 inches deep, into the laboratory and subject them to known and controlled amounts and rates of artificial rainfall by means of controlled sprays. This would require the use of broad, shallow, water-tight containers which might be of wood lined with soldered and painted tin. It would also be necessary to use a sufficient

number of sprays to cover completely the soil in the containers to simulate rainfall. The amount of water used could be computed in inches of rainfall, and the rate of rainfall simulated could be easily determined. The rates of rainfall could be varied over a wide range to correspond with actual rainfall conditions, and the containers could be set at as many angles and slopes as desired.

"The laboratory data on washability thus obtained could be correlated with the physical and chemical properties of the soils and information of a general nature be obtained as to what may be expected in the way of erosion from similar soils under similar conditions in the field. The most important information to be obtained from such studies, however, would be that which indicates what is lacking in such soils or what property they possess which causes or permits them to erode. The supposition is that clay soils and sand-clay soils tend to erode under the wearing action of water owing to the absence of organic colloids or of colloidal cementing material which tends to increase their cohesive properties in the presence of moisture.

"In this connection I would suggest an extension of the laboratory studies to include similar tests of the same soils modified by various treatments mentioned above until the tendency to erode under the worst conditions is brought down to a minimum.

"Obviously the aim of such experiments would be to increase the wearing resistance of the soil against the erosive action of water in the same manner that studies in alloys and heat treating are intended to increase the wearing power of iron and steel against stress and abrasion. I do not believe that much expense would be incurred in such laboratory studies from the standpoint of apparatus, the time of the investigators being probably the greatest expense.

"In addition, such studies should indicate the best and least expensive methods of undertaking the subsequent field experiments. The method of selecting a given area and causing all soil that is carried away by water to be collected immediately below the plat is probably the most accurate but also the most expensive. Thus the great importance of as much preliminary knowledge as possible is evident. Probably the only way that this method can be operated with any degree of accuracy will be to construct a concrete-lined ditch or catch basin as cheaply as possible at the foot of each plat of soil washed from the plat during the season. Prevailing soil types which are most subject to erosion should be selected for the field study, and it is believed that the laboratory studies should be duplicated in the field in so far as the results justify. Ozviously it will be necessary to keep an accurate record of rainfall and its distribution in order to correlate amounts of rainfall with such factors as temperature, vegetation, soil treatments, etc.

Plat Contour of Experimental Area

"The method of taking precise levels over a plat would probably be quite inaccurate. It could, however, be used as a check over the other method and might allow some interesting progress information, especially after heavy rainstorms. I suggest, therefore, that at the beginning of such a field experiment very careful precise levels be taken over a plat at the points of squares or triangles, and that the contour of its surface be carefully platted on paper. Then if anything should happen to the experiments as conducted by the other method, the results would not be entirely lost. I believe this to be important, since it is easy to conceive of heavy storm conditions which might destroy such field apparatus.

"I do not believe it advisable to undertake comparative studies of terracing or other methods of preventing erosion until some such preliminary work as I have outlined has been undertaken. The amount of soil removed by rainfall from a specific soil type under optimum physical and chemical conditions with reference to resistance to erosion is undoubtedly the basis for the development of such preventive measures. The bringing of the soil into an optimum condition of resistance can, of course, be done only after the proper preliminary experiments have been completed. Such corrective measures in their turn can not be established until the lacking factor in the soil is also determined by proper preliminary laboratory studies."

Some types of soil seem to wash more easily than others, consequently in terracing land to prevent erosion, it is sometimes a guess as to just what fall to give the terrace. After one has done terracing in a certain section for several years, he knows by experience the best grade to give the terrace for that section. However, this experimental or trial method is sometimes expensive, for the terrace often breaks, or gullies are cut along the terrace when the fall is too great. This phase of soil erosion would be worth a little research work. A lot of good data has been, and can be obtained, from the field, but it seems quite possible to get some good facts from a miniature field, using a large number of types of soils, as outlined above.

It has been found that if terraces are given the same fall in Southwest Oklahoma as in Southeast Oklahoma, washing will occur along the terrace. This is apparently due partly to soil and partly to climatic conditions. This problem of grade of terrace and fall between terraces is a phase of the work that caused considerable discussion at the November, 1923, annual meeting of the American Society of Agricultural Engineers. From this discussion it was learned that some agricultural engineers use the variable grade, while others use the constant grade. This point is worth some investigational work. There was some dispute as to length of a terrace and the fall between terraces. These two problems would be rather hard to subject to definite research treatment. However, some valuable information might be obtained from past experiences.

To Determine the Fall Between Terraces

Mr. J. T. Copeland, specialist in agricultural engineering of the Mississippi Agricultural and Mechanical College, has been working on this problem. To determine the fall between terraces he determines the fall between the beginning of the gully near the top of the hill and the next one down the hill, etc. In other words, he puts the terrace on the beginning of the gullies nearest the top of the hill and the next terrace on the beginning of the second series of gullies, and gives the terrace in inches equal to the number of feet of fall between terraces. This appears feasible, but it is believed that it should be tried out in various states. It works all right on land with a rather steep slope where the rainfall is considerable, but in the western part of Oklahoma where fields are large and there are long spells between rains, it is rather hard to locate the upper end of these gullies.

Another problem apparently worth considering for research is the amount of soil leaving the land with each acre-inch of water for various slopes and types of soil. With this information given to the farmer, the writer feels sure that he will be awakened much sooner than he will with the mere statement that a lot of soil is leaving his field at each rain. The method that the writer has chosen for starting this work is through the agricultural engineering club boys. Each boy has been asked to get a gallon of water that is running down a gully in a cultivated field to determine the amount of soil in it, then to figure the amount of soil leaving the field with each acre-inch of water. The boy is also asked to determine the slope of the land and type of soil where the water was obtained. Another problem required of the boy is to do the same thing as above with water taken from the upper side of a terrace. This may not give the results expected, but it is believed it will at least give some important information as to the value and effectiveness of a terrace. This experiment may also be conducted on a small scale, using different types of soil, different slopes, etc. The interesting work conducted by Messrs. F. L. Duley and M. F. Miller at the Missouri agricultural experiment station (Mo. Research Bull. 63—1923—pp. 5-50) should be noted in this connection. Experiments covering a 6-year period were conducted, in which the amount of run-off and soil eroded were measured after each rain from seven plats having different cropping systems or tillage treatments. The plats which were each 1/80 acre in area were elongated in form

and ran up and down a slope averaging 3.68 to 100 feet. Concrete tanks at the lower ends served to collect the run-off and eroded soil from each plat. Each plat was given a different treatment, which included (1) no cultivation with all weeds pulled, (2) 4-inch spading in the spring and cultivation after rains, (3) 8-inch spading in the spring and cultivation after rains, (4) blue grass sod, (5) wheat annually, (6) a rotation of corn, wheat and clover, and (7) corn annually.

The average run-off varied from 48.92 per cent of the rainfall on the uncultivated plat to 11.55 per cent on the blue grass sod plat. The land spaded 8 inches deep in the spring absorbed only 2.9 per cent more rainfall than that spaded 4 inches. This is taken to indicate that deep plowing of farm lands can be expected to have only a slight advantage over shallow plowing with reference to the absorption of rainfall. Uncropped land, whether cultivated or uncultivated, absorbed much less water than grass or clover land. Land in a rotation of corn, wheat, and clover lost only 14.14 per cent of the rainfall as run-off. The surface inches of rainfall absorbed by uncropped land or by land growing a cultivated crop like corn was practically constant from year to year for a given soil condition, regardless of the wide variation in the annual precipitation. The absorption by sod, wheat, and rotated land was more variable.

Deep spading reduced the loss from erosion only 13.4 per cent as compared with the shallow spading. This is taken to indicate that deep plowing is less effective in controlling erosion than is usually supposed. In addition, the total loss from the deep-spaded land without a crop was very high as compared with cropped land. The presence of a corn crop reduced the erosion of deep-spaded land 50 per cent as compared with the uncropped land, wheat reduced it 81 per cent, and rotation 93 per cent. Sod land lost only 0.68 per cent as much soil as the uncropped soil spaded 4 inches deep.

A direct correlation of the amount of soil eroded with the number of heavy rains occuring during the year showed that the soil eroded during sixteen of the most destructive rains in the six years under consideration was more than 50 per cent of the total erosion on five of the seven plats.

The results as a whole are taken to indicate that much can be done in the corn belt towards reducing run-off and the disastrous effects of erosion by planning crop rotations in such a way that the land will be covered with a growing crop a very large portion of the time.

Another phase of terracing the writer believes worthy of investigation is to determine the value of a terrace in the conservation of moisture. Two methods may be used, i. e., the miniature field method, and the moisture test method. In the miniature field method soil and subsoil may be put into a large metal pan made for the purpose, the surface given different slopes and a sprinkler used for rain. A meter should be used to determine the amount of water applied, or probably a small elevated tank would be more accurate. The run-off should be caught and measured. If this is done with the field terraced, and also unterraced with gullies in it, it is believed that some information worth while can be obtained. In the moisture test method a field of uniform soil and slope should be selected, part of it terraced and part left unterraced. Moisture tests of soil and subsoil should be taken regularly throughout the year in both dry and wet weather. Some valuable information as to the value of a terrace in storing and conserving moisture may thus be obtained.

The A. S. A. E. Committee on Soil Erosion has done and still is doing some valuable work on soil erosion. It is considered desirable that members of this committee and also others take some phase of soil erosion as a research problem.

In conclusion the phases of soil erosion, discussed in this article, that seem feasible for research work are briefly as follows:

1. Value of humus in soil to retard soil erosion.
2. The grade to give a terrace for the different types of soil and slopes of land.
3. The comparative efficiencies of the variable and constant grade of terrace.
4. The fall between terraces for different slopes.
5. Amount of soil leaving an acre of land with each acre-inch of water on various types of soil and slope of land.
6. The value of terracing on the conservation of moisture.

Research in Agricultural Engineering—1923*

By R. W. Trullinger

Mem. A. S. A. E. Specialist in Rural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

(Continued from the June issue.)

Farm Water Supply and Sewage Disposal

There is a record of twelve projects in farm sewage disposal at eight experiment stations in the states of Montana, Minnesota, Missouri, New Jersey, Illinois, New York, Michigan, and California, and at the Kansas State Agricultural College and the Pennsylvania State College. The importance of a consideration of this subject from its logical beginning through its scientific contacts to an ultimately practical solution for definite groups and classes of conditions is strongly emphasized by some of these projects.

A careful consideration of all the factors involved, with particular reference to the object to be accomplished by sewage disposal measures, seems to indicate the importance of first studying, analyzing, and classifying the conditions to be met by such measures. This was done in a tentative and general way by the writer, but in a manner sufficiently comprehensive to show the possibilities of such a procedure. (See American Society of Agricultural Engineers Trans., 11 (1917), pp. 67-76.)

The works of the New York (Cornell) station and Pennsylvania State College and of several of the state departments of health have shown that such a procedure is well worthy of consideration as a preliminary to undertaking studies on farm sewage disposal.

If the conditions to be met in a locality fall within a class or group requiring the absolute purification of the sewage, then the objective is clearly evident. From that point on the thing most vitally affected is the sewage itself, and ways and means of bringing about its purification must be made to conform to the requirements for its transformation from the raw to the purified state. Obviously then, the services of the chemist and bacteriologist should be enlisted by the engineer in determining the nature of the processes involved in such transformation, and the absorptive and oxidizing properties of soils should also receive consideration.

With at least some of these objects in view, the Illinois station has undertaken a co-operative project designed to bring out some of the relations between sewage tank dimensions and the chemical and biological changes taking place therein. The New Jersey stations are continuing their study of sewage filter biology and the Montana station is still engaged in a study of the factors governing the operation of septic and Imhoff tanks. The Kansas State Agricultural College is also developing a fundamental study of the sub-

*1923 report of the A. S. A. E. Committee on Agricultural Engineering Research.

ject, based largely upon the principles outlined above, which is well worthy of mention.

Attention may well be drawn at this time to studies on specific features of sewage disposal to indicate its scientific complexity and to emphasize the importance of getting at and considering all of the facts involved. For instance, the New Jersey stations and the New Jersey State Department of Health in preliminary studies of the fauna of the Imhoff tank showed the existence of a relatively stable population composed of the more minute forms of protocoa of which the minute flagellates in dimensions of less than thirty microns were the predominant forms. These fluctuated in numbers somewhat with respect to the acidity of the sewage. Studies by the health department of the Dutch East Indies to determine the duration of life of cholera and typhoid organisms when introduced into several small sized septic tanks showed that, even under the favorable conditions due to high temperature of the locality, the pathogenic organisms always appeared in the effluent from the infected tanks within a few hours after infection. Studies at a well known tuberculosis sanatarium to determine the frequency with which tubercle bacilli are present in the effluent from a small Imhoff tank receiving the sewage from the institution, showed that the effluent nearly always contained living active tubercle bacilli and that supplementary chlorin treatment was necessary to kill them. Preliminary treatment of the sewage to reduce it completely to liquid form was found necessary. These studies of pathogenic organisms in sewage and small sewage tanks offer considerable food for thought in connection with much of the so-called practical information on small sewage disposal plants which is now available.

With reference to new purification methods, the work of the Argentina Chemical Society on the purification of septic tank effluent with clay or loess silt should be mentioned. Loess silt had a marked influence in reducing the putrescibility of sewage effluent. The reduction of the organic matter increased with the time of contact with the silt up to four hours. The amount and degree of pulverization of the silt also had a marked influence. The results are taken to indicate that this influence is mainly over the putrefactive bacteria. Studies at a German engineering experiment station on the use of peat dust in latrine operation and in privy vaults showed that the peat reduced the liquids, gases, and odors.

Obviously the development of sewage disposal methods and apparatus is simplified as the standards of purity required by the grouping of conditions are lowered. This is an important economic consideration which has been emphasized by the works of several of the state boards of health and which shows the advantage of a preliminary analysis and grouping of all factors and conditions involved.

There is plenty of evidence to show that much study is needed of ways and means of securing clean water on farms. With this in view, the U. S. Public Health Service has been studying the principles underlying the movement of "Bacillus coli" in ground water in relation to the pollution of wells. Natural fecal material from privies was used as the polluting material, Bacillus coli was taken as the bacterial test, and uranin dye was used in tracing the movement of polluted water from trenches to more than 400 experimental wells. The soil was fine sand with an effective size of 0.13 millimeters. The results showed that pollution with fecal Bacillus coli could be followed in ground water for distances of 3, 6, 10, 15, 25, 35, 45, 50, 55, 60, and 65 feet from the trench in which pollution was placed. In addition, uranin was recovered from these same wells and from wells at distances of 70, 75, 80, 85, 90, 95, 100, 110, and 115 feet from the pollution trench. Pollution traveled these distances within a period of 27 weeks, and only in the direction of the flow of the ground water and in a thin sheet at the surface of the zone of saturation. Even when heavy pollution was recovered at the top, water from lower levels was negative both for uranin and Bacillus coli. All evidence obtained indicated that when the ground water level falls the pollution remains practically stranded in the capillary fringe or in the intermediate belt. It was further found that the progressive movement and the stranding of the pollution are intimately connected with, are dependent upon, and alternate with the rise and fall of the ground water level, and this latter factor is dependent upon the alternation of wet and dry weather. In further studies human feces were buried in pits in a locality of high ground water and covered with sawdust. Of five samples taken three years and two months after burial all were both macroscopically and microscopically recognizable as-feces. Three of these samples were positive and two were negative for Bacillus coli. The practical bearing of these results upon the intermittent pollution of wells, the location and protection of water supplies, and the justification for laws forbidding the use of abandoned wells for the disposal of excreta are self evident.

Studies in India on the purification of water by aerated and bacterized river silt showed that such silt is capable of causing the rapid oxidation of dissolved organic matter in polluted water. Studies by the department of health of the Dutch East Indies showed the effectiveness of so-called autopurification in removing pathogenic organisms from water exposed to the direct rays of the sun. This purifying action is attributed chiefly to the influence of protozoa. The flagellates especially multiplied in such water and destroyed such pathogenic bacteria as cholera, dysentery, and typhoid. This action was more rapid and complete at temperatures of from 29 to 30 degrees Centigrade. The Calcutta School of Tropical Medicine has also made important contributions to the knowledge of the bacteriology of small water supplies. The importance of knowing more about the scientific phases of water purification, especially on a small scale, is thus plainly evident.

Land Clearing

While the subject of land clearing has developed rapidly from a miscellaneous matter to one of prime importance, it is yet quite indefinite in nature, and it is difficult in many cases to see wherein the principles of research may be applied. In spite of this, there are at least thirteen distinct projects in land clearing at six stations in the states of Idaho, Minnesota, California, Oregon, Wisconsin, and Alabama. Most of these projects deal with a comparison of methods of land clearing and with cost determinations and comparisons, and in spite of the nature of the work many are aimed toward rather definite objectives. The work at the Alabama station on the use of explosives in land clearing and the destructive distillation of the stumps to pay the cost of clearing has been mentioned in previous reports. The works at the Idaho and the Oregon stations deal specifically with methods such as dynamiting and mechanical pulling. The well-known works at the Wisconsin and Minnesota stations constitute perhaps the most comprehensive projects on the subject at the stations in that they not only deal with stump and brush removal by various methods including explosives and machinery, but have involved the development of new types of plows and cultivating machinery adapted specifically to the breaking and cultivation of the cleared land. In the latter connection it has been found at the Wisconsin station that the chief difficulty with brush breaking plows is that roots and brush accumulate under the beam and throw the plow out of the ground. When the beam is offset to the left side of the plow, the accumulation of brush, roots, and trash under the beam is greatly reduced and the space directly in front of and above the plow remains relatively free. Investigations in marsh plowing showed that the 20-inch plow usually requires a 12 to 15 horsepower drawbar rating in the tractor. Tractors weighing from 4,500 to 6,000 pounds operated most satisfactorily in practice, but wheel tractors required that the rear wheels be at least 20 inches wide with angle iron lugs at least 3 inches and preferably 4 inches wide.

The work at the Oregon station is also quite comprehensive. One of the features of this work has been the development of a new stump burning method adapted to the clearing of big stump land, which involves the use of a furnace, hood, draft pipes, and chimney. By means of these a hole is burned through the base of the stump, and the stump itself is converted into a stove, which with its own draft, chimney,

and fuel develops a fire in its interior so intense as to insure its combustion and the firing of the roots. When this is done, the stump is banked in with earth and the crown and roots are burned out below plow depth as a char pit. It has been found that with certain minor exceptions any species of stump of reasonably sound combustible wood or of sufficient size to justify the use of fire, and with roots sufficiently large to carry a fire well, is a desirable subject for the use of the burner. The bigger the stump the better it burns, and the cost of burning has been found to decrease as the diameter of the stump increases. The removal of smaller stumps up to eighteen inches in diameter is best accomplished with a puller supplemented with explosives. Only sandy soils were found to be unsatisfactory for the use of this method.

Studies at the California station on the killing of trees and stumps with the Australian arsenical formula, consisting of a mixture of one pound of white arsenious oxid, one pound of washing soda, and four gallons of water, showed that ten species of eucalyptus were treated with perfect success.

Materials of Construction

Materials of construction is a subject which has developed from a minor miscellaneous matter to one of the most important branches of agricultural engineering, and its rise to a position of such importance can be considered as a natural result of the development of agricultural engineering as a whole, owing to its close relation to all other branches of the subject. There is a record of at least twenty-two projects at ten stations in the states of Iowa, Montana, Alabama, Minnesota, Pennsylvania, Ohio, Missouri, New York, Wyoming, and Colorado. A great many of these projects have been of a very general and apparently comparative nature.

Some, however, have quite definite objectives which frequently take years to attain. For instance, the work at the Iowa station on the preservative treatment of farm timbers, which has been carried on for sixteen years, has shown that the quick growing, nondurable Iowa woods can be successfully used for fence post purposes after having been treated with creosote and that durable fence post woods, such as white cedar, can be made to last for a long period of years with little deterioration after creosote treatment. Results of a similar nature have been obtained by the Missouri and Michigan stations and by the U. S. Department of Agriculture, working in co-operation with several of the state experiment stations. The latter studies have also shown in general that the durability of posts, whether treated or untreated, is influenced by a number of factors, such as species, method of seasoning, size of post, proportion of heartwood to sapwood, shape, and soil and climatic conditions. Radial penetration of a preservative, especially at the ground line, tops, and butts was found to be of prime importance.

A nine-year study at the Iowa station of over seven hundred concrete fence posts of different types has indicated that four 0.25 inch square twisted reinforcement rods are necessary to develop maximum strength without the excessive use of steel.

Special attention should be drawn to the work of the U. S. D. A. Forest Products Laboratory at Madison, Wisconsin, on wood as a structural material. Prominent in this are the studies in progress on moisture resistant coatings for wood. These have so far indicated the ineffectiveness of linseed oil in preventing moisture changes in wood, and have shown the superiority in this respect of a bronze coating of a cheap gloss oil and aluminum powder over any other treatment used. Other studies have demonstrated the value of either hot or cold coatings for the prevention of end checks in wood for drying temperatures up to 140 degrees Fahrenheit and of hot coatings for temperatures up to 170 degrees. No coating is entirely satisfactory above 170 degrees. Still further studies have resulted in basic grading rules and working stresses for structural timbers and standard grading specifications for yard lumber.

Studies at Cornell University on the end bearing strength of wood on surfaces inclined to the fibers indicated the superiority of the Howe formula for the strength of timber obliquely to the grain over the Jacoby formula, and showed that the allowable stress for bearings on the ends of the fibers parallel to the grain should be raised to be commensurate with that used when stresses are perpendicular to the grain.

Studies conducted under the direction of the Franklin Institute on the plasticity of paint have indicated that suspensions made up of white lithopone and pure acid refined linseed oil show the properties of plastic materials even at very low concentrations of the disperse phase. Viscosity is a function of the shearing stress. At high concentrations the relation of yield value to concentration is linear and the material is truly plastic, while at lower concentrations the relation is not linear and the material is considered to be pseudo-plastic.

Studies at the Minnesota station on the effect of organic decomposition products in soils of high vegetable content upon concrete draintile showed that concrete tile contain free alkali as an inseparable characteristic. This reacts with acid organic compounds from peat soils, producing gelatinous compounds which are soluble in water containing carbon dioxide. Therefore, concrete tile as at present made are likely to fail as drainage structures when used in peat soils in the presence of water.

Several other projects of research on concrete have been in operation which are of interest to agricultural engineers. Among these are the studies by the Lewis Institute on stone screenings as fine aggregate for concrete. These showed that good concrete can be made with stone screenings as fine aggregate, but that proper grading to eradicate an excess of dust and extremely coarse particles and the use of not too much water are important factors. Studies on the setting of Portland cement by the British Portland Cement Research Association showed that the time of setting of cement does not change of itself and appears to depend upon the proportion of combined water present in hydrated calcium aluminate or silicate, which tends to form a protective coating around the particles of cement and delay penetration of water to the active core. The greater the quantity of water absorbed by the cement the more impervious is the protective film and the slower is the time of setting. On the other hand, setting is accelerated by any influence which withdraws water from the cement or which attacks, destroys, or modifies the film of hydrated material.

Studies conducted at the University of Michigan on integral waterproofings for concrete showed that insoluble soaps and petroleum residues decreased the absorption of concrete by one-half and showed that hydrated lime and clay can not be used as waterproofing agents owing to their injurious effect on the strength of the concrete.

The U. S. Bureau of Standards has developed inundation methods for measurements of sand in making concrete and the U. S. Department of Agriculture in co-operation with Purdue University has studied the effect of repeated loads on concrete slabs.

Miscellaneous

As usual, there are several miscellaneous studies in agricultural engineering which should be mentioned. The record shows about eighteen different projects on miscellaneous subjects at nine stations in the states of Indiana, Illinois, Iowa, Wisconsin, Minnesota, Alabama, Montana, Missouri, and Virginia. These projects include work on soil erosion and its prevention, farm power, harvesting and storage of ice, farm electric plants, and hydroelectric development.

Perhaps the most extensive work is that at the Illinois station and at the Iowa station in co-operation with the Committee on Animal Motors of the American Society of Agricultural Engineers on different phases of farm power. The studies of the committee on animal power on the absolute pulling powers of mules and horses are well known. Soil erosion and methods for its prevention are commanding considerable attention, particularly in the South Atlantic and Gulf Coast states. It would seem that this subject offers considerable opportunity for fundamental study. Most of the work hitherto undertaken has consisted of comparative tests

(Continued on page 165)

Survey of Agricultural Engineering Progress

A review of current literature on engineering as applied to agriculture prepared monthly by Robert W. Trullinger, Mem. A. S. A. E., specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Chimneys for Heating Boilers, A. G. King. (Dom. Engin., Chicago, 106 (1924), No. 7, pp. 20-23, figs. 5.) Information and tabular data for use in the design of chimneys for house-heating boilers are presented.

Intake Manifold Distribution, H. W. Asire. (Journal Society of Automotive Engineers, New York 14 (1924), No. 4, pp. 387-395, figs. 22). Studies on the nature of the distribution of gases to the cylinders of internal-combustion engines on the comparative effectiveness of different types of manifold are reported.

It is shown that because of the low volatility of commercial fuels heat must be applied if distribution in the gasoline state is to be obtained. If the fuel is not vaporized by hot spots or other preheating devices, about one-half of it must be distributed as liquid at 70 degrees Fahrenheit. At low temperatures nearly all the fuel reaches the cylinder in a liquid state during the warming-up periods. If sufficient heat is applied to dry the mixture, the resulting mixture temperatures will be so high that the engine will be sensitive to detonation. If the compression is reduced to eliminate detonation the power and economy are also reduced.

All of the commercial manifolds tested cold exhibited practically no inherent ability to distribute liquid. It was found that the three main factors controlling the flow of air and liquid fuel in a manifold are (1) the stratification of liquid with respect to air, (2) puddles of liquid that are formed in the manifold in dead-air pockets, and (3) the effect of the firing order.

Stratification was found to result from the fact that liquid fuel, which is heavier than air, is carried in the air stream in drops of varying size. Whenever the air stream makes a turn some of the drops of liquid continue in the same direction as formerly. Stratification starts at the first turn, usually at the throttle, and becomes worse at each bend. Puddles that form as a result of stratification and from other causes were found to constitute a source of supply for the first cylinder demanding a charge, after that manifold branch has remained inactive during the functioning of another branch.

It is concluded that this could be controlled more readily if air flow could be attained without turbulence. Since the forces involved are large and air is a very light weight mobile fluid, freak flow was found to result around every sharp bend and every protruding corner. The conventional throttle is one of the main causes of turbulent air flow, which constantly changes its path even though the mechanical adjustments remain unaltered. Uuder conditions of steady or uniformly pulsing air flow, it was found that the puddles in the air pockets remain practically constant in size, but these conditions seldom occur.

Sand Bed Studies at Montebello Water Filters, Baltimore, I, II, J. R. Bayliss. (Engineering News-Record, New York, 92 (1924), Nos. 13, pp. 516-512, figs. 9: 14, pp. 563-568). This report is in two parts. In part I observations of the individual sand grains of a sewage filter with a camera lucida are reported, which disclosed a gelatinous coating, the thickness of which affected the efficiency of the filter. Cracks, mud balls, and clogged places were found to be due largely to the loose settling of the filter after washing, and to subsequent settlement while filtering. An excessive gelatinous coating around the sand grains caused the loose settling.

After several years of close physical and microscopic examination of the sand experiments in the operation of the filters, it was found that the removal of a portion of the gelatinous coating by direct jet action of wash water applied through perforated pipes near the sand surface maintained the beds in a satisfactory condition during summer and winter. Due to the excess of the gelatinous film a larger sand grain was found to be preferable in summer, but in winter the film grew less vigorously and a smaller grain was desirable. The proper mean was found to be about 0.6 millimeter. The size, composition, and other characteristics of the grains had little influence on the thickness of coating formed if there was no force tending to remove it, but the size had a great effect on the settlement. Due to abrasion in washing, size greatly affected the amount of coating that was retainer on the grains.

The remedy for such troubles as the pulling away of the beds from the side walls, the formation of cracks and clogged places, and bacterial growths when the proper size of sand was used, was found to prevent the formation of an excessively thick gelatinous coating or organic incrustation around the sand grains.

Design and Construction of Small, Concrete-Lined Canals, W. E. Cole. (Arizona Station Bulletin 97 (1923), pp. 37, figs. 23). Information is presented on the design aind construction of small concrete-lined irrigation canals, including tabular data on the hydraulic elements of such canals.

Linings of from one to two inches in thickness have been used successfully in regions where the frost action is not serious. Present practice tends to make 1.5 inches the minimum thickness, but a greater thickness should be used for large canals and steep side slopes. The slope and thickness should be designed so as to eliminate inside forms, which materially increase the cost. The use of a 2-inch lining on a small canal having a side slope of 2 or 3 to 1 seems to be the limit in that direction. Steeper slopes would require a greater thickness.

Canals located on unstable foundations such as occur in swampy places and on fills require strength to resist side and bottom pressure and unequal settlement. Increased thickness, beam effects, and reinforcing have been found to produce the desired results. On fills especially the lining should be tight to prevent saturation of the material of the fill.

Concrete-lined canals should be protected from injury by stock. The growth of trees along the bank should be discouraged, since the roots will force their way through cracks in the lining and eventually rupture it. Gopher holes next to the concrete are dangerous in that the foundation is weakened. By for the greatest danger is from the entrance of flood water from the sides, and considerable care should be exercised at all drainage ways to provide ample capacity for all such waters.

The cost of 2-inch concrete on two Arizona projects, including the preparation of the earth foundation, the cost of materials, and the placing of the concrete, was found to be 10.5 and 11 cents per square foot, respectively.

Engine Cooling Systems and Radiator Operating Characteristics, N. S. Diamant. (Journal Society of Automotive Engineers, New York 14 (1924), No. 4, pp. 396-406, figs, 14... In the first part of this paper a general quantitative comparison of air, water, and oil-cooled cylinders is given as it relates to the subjects of heat transfer and temperature drop. In the second part an attempt is made to discuss the performance or operating characteristics of radiators from the point of view of the truck or tractor designer. A large amount of tabular and graphic date is reported.

These show that the order of magnitude of the heat transferred per square inch of surface per 100 degrees Fahrenheit temperature difference between the cylinder metal and the cooling medium is about 100 for water, 1 for air, and 10 for oil, depending upon the rate of flow, its turbulence, and other factors. The cooling capacity of radiators increases with the air flow. For radiators having no fins the increase is nearly directly proportional and doubling the air flow doubles the cooling capacity. For radiators having fins or an indirect cooling surface swept by air on both sides, the cooling capacity does not increase so rapidly as the air velocity.

The amount of air flowing through a radiator traveling in still air depends upon the resistance of the core and the resistance of the remainder of the air circuit under the hood. In general, a propeller or curved blade type of fan will draw more air through a high resistance core than through a low resistance core. The opposite is true for a disk type of fan.

For engines having pump circulation the cooling capacity of the radiator begine to decrease as the rate of flow begins to fall below three gallons per minute per foot of width per inch of thickness of the core.

Book Review

...."**Meal Planning and Table Service.**" by N. Beth Bailey, associate professor of household science, Iowa State College. This book restricts its field to the planning and serving of regular family meals in the no-servant home. It is a composite of dogmatic assertions which, at the same time, invites you to take your choice. The fundamental processes are analyzed and the basic rules are given, thus answering the demand for a practical method of daliy serving in the average home. The salient points in correct table service have been kept in mind, namely, reducing the service to essential motions as to avoid annoyance to those at the table, and although written for textbook use, the book appeals equally to the homemaker. The book contains chapters on the art of entertaining and being entertained, the choice of equipment for the dining room, the rules of table service, principles of menu placing, menus and service for special occasions, and how to serve food attractively. The book is published by the Manual Arts Press, Peoria, Illinois, and the price is $1.60 postpaid.

Soldering. J. Grant Dent, instructor in agricultural engineering at the University of Minnesota, is the author of a new book just off the press on soldering, written especially for farmers, garagemen, radio builders, teachers, and everyone who has use for a knowledge of soldering. It contains a special chapter giving equipment and exercises for farm shop teachers in college or school. Information is also given on tinning the soldering copper, use of flux, soldering the ordinary metals and special work such as cast iron, aluminum, and enamel ware. The book is on sale at the Students Book Store, University Farm, St. Paul, Minnesota, the price of which is 25 cents postpaid.

A. S. A. E. and Related Engineering Activities

Agricultural Engineers Meet at Lincoln

DURING the past few years meetings of the American Society of Agricultural Engineers have been noteworthy for the more than usual evidence of the rapid strides being made in the development of an agricultural engineering science. The highly scientific character of papers and reports presented abundantly bears witness to the remarkable progress that is being made in this comparatively new branch of engineering. Agricultural engineering has had to run the gauntlet the same as other new ideas; while engineers in the older, more established fields were pooh-poohing the idea of agricultural engineering as a distinct profession, the sturdy pioneers—Davidson, Chase, Boss, Rose, White and the rest, together with their "offspring" and others who saw the light and followed it—have all these years been saying not too much and "sawing wood." Today no argument is needed to prove that agricultural engineering has justified a prominent and enduring place for itself along with other branches of engineering; a "pile" of evidence has been accumulated to prove that fact, much of which evidence is to be found in the A. S. A. E. Transactions.

A large addition to our pile of evidence has been made as a result of the eighteenth annual meeting of the Society held at Lincoln, Nebraska, June 18, 19 and 20, 1924. Many felt that, when we got so far away from Chicago, our attendance would fall off, but such was not the case at Lincoln, where was recorded the largest registration of any previous meeting of the Society.

An indication of the importance members put on A. S. A. E. meetings, in the way of new inspiration and other valuable helps they get out of them, is in the number that come from great distances—most of them at their own expense—to attend these agricultural engineer get-togethers. This year more than half the states of the union were represented; members came from as far east as Connecticut, as far west as California, as far north as Minnesota (yes, farther—Saskatchewan), and as far south as Alabama, and Florida; California, for example, was represented by five men, and there was the same number from Alabama.

The program arranged by the Meetings Committee more than came up to expectations, and the Committee deserves a great deal of credit for its splendid work. Space will not permit even a brief review here of the papers and reports presented; many of them will appear in the Transactions of the Society, and also in AGRICULTURAL ENGINEERING. As has been the case in the past, the papers and reports generally represented a higher order of scientific work, which is indicative not only of the rapid advance being made in agricultural engineering science but more particularly of the more scientific attitude and greater development that has taken place in the individual agricultural engineer, who has been principally responsible for the advance that has been made.

An impressive thing about the Lincoln meeting—and of the utmost importance to all agricultural engineers—was the fact brought that, for the most part, the men who are taking the lead in developing our profession, who are contributing most to the advancement of the art and science of engineering as applied to agriculture, and who present the best papers and reports, are the ones who have been most regular in attendance at A. S. A. E. meetings. There are many specific instances where the inspiration for a valuable piece of scientific work in agricultural engineering has come from attending a meeting of this Society.

Many new faces were seen at the Lincoln meeting—men who had been members for some time but who had never attended an annual meeting before. These men were greatly surprised at the tremendous value to be derived from these meetings, and genuinely regretful that they had not discovered it before. It would seem that all that is necessary for a member to consider inability to attend an annual meeting little short of a calamity, is for him to attend just one of our meetings and get the inspiration and absorb some of the enthusiasm that prevails there.

With the exception of the business meeting, banquet and general sessions, the various division meetings at Lincoln were held in the agricultural engineering building, one of the largest and best equipped of its kind in the country. This provided an atmosphere particularly fitting for our meeting, and one thoroughly appreciated by those in attendance. Judging from the sentiments expressed during the meeting, the idea of holding future annual meetings at agricultural colleges is very much in favor.

It should be said at this point that the success of the Lincoln meeting was in a large measure due to the efforts of the local committee in arranging for the comfort and enjoyment of the guests. Not a detail was missed, and the way the entire convention was handled, from start to finish, would do credit to a corps of professional convention managers.

The department of agricultural engineering at the University of Nebraska is manned by a group of men who are not only good agricultural engineers but also organizers and entertainers of the first order. To these men and other A. S. A. E. members in Lincoln who helped, our hats are off for the way they "put over" the convention.

The annual A. S. A. E. banquet on Thursday evening was a most fitting climax to all that had preceded. To say that "a good time was had by all" only mildly expresses it; it was a rip-roaring banquet—a laugh from start to finish. One person was heard to remark that he had not laughed so much in fifteen years. We remember back when it was a difficult undertaking to get a respectable number of our annual meeting attendants together for a banquet, but now you couldn't keep them away with a club.

Nebraska agricultural engineers have established a new record in making A. S. A. E. conventions go—a record that will not be easy to beat; however, there are other groups that stand ready to try it.

The holding of two professional division meetings simultaneously at our annual meetings has proven a very satisfactory arrangement; the success of this plan is now well established and will no doubt feature future annual meetings.

The development in agricultural engineering is taking place so rapidly that there is not sufficient time at our annual meetings to feature anywhere near all the new advances that are being made. For that reason it is becoming necessary to supplement annual meetings with separate meetings of professional divisions during the year. In this connection a meeting of the Farm Power and Machinery Division for this coming fall is contemplated at this time.

Well Drillers Meet

OF considerable significance to agricultural engineers is the meeting that was held in February at St. Paul, Minnesota, of about one hundred and twenty-five well drillers from Minnesota, North and South Dakota, Iowa, Wisconsin, and Michigan. The occasion was the second annual meeting of the Minnesota Well Drillers Association.

This is the second organization of its kind, the first being the North Dakota Well Drillers Association which

came into existence in 1915. Though both organizations are voluntary associations of well drillers, they are assisted by the respective state universities. The North Dakota association has been assisted and advised by Prof. H. E. Simpson, of the department of geology. The Minnesota association likewise has been assisted by Prof. E A. Stewart (Mem. A. S. A. E.) of the University of Minnesota.

The motto of both associations is "Every well driller the water specialist in his community." The opportunity for state agricultural colleges to render a valuable service to the well drillers and through them to every community in the state is so obvious and the movement in both of these states has received such enthusiastic response from the drillers that it seems probable that similar associations of water well drillers will be organized in other states. Such organizations will obviously afford an excellent opportunity for helpful contact between the U. S. Geological Survey and the drillers of the country.

Here seems to be a field that agricultural engineers thus far have not paid a great deal of attention to, but which is unquestionably one of the most important phases of farm water supply which is strictly within the purview of the agricultural engineer.

Personals

Wendell P. Miller has resigned his position as extension specialist in agricultural engineering with the Ohio State University and has opened an office at 4 Fifteenth Avenue, Columbus, Ohio, to engage in the general practice of agricultural engineering, specializing in land drainage and the development of country estates.

Max E. Cook has resigned his position as farmstead engineer with the California State Land Settlement Board and has opened an office for the California Redwood Association at 315 West Fifth Street, Los Angeles, California. He will continue to devote his attention to promoting the improvement of farm buildings.

Research in Agricultural Engineering—1923

(Continued from page 162)

of terraces of different shapes, sizes, and grades. It is believed that this work should start with a consideration of the factors governing the erosion of soil by water, the influence of different treatments on these factors and the amount of soil removed by running water under known conditions. With this as a basis, studies could then be intelligently undertaken to develop methods of prevention of erosion. The work at the Missouri station is believed to be more or less typical of such a procedure.

Conclusion

This critical study of investigational and research work in agricultural engineering during the year has brought out the fact that while there is a marked growth in the research attitude, much is yet to be learned about the best methods of approach to problems for study. The importance of beginning all studies with the factor or thing most vitally concerned is strongly emphasized throughout the work of the year.

More specifically, the work emphasizes the importance of fundamental studies of soil mechanics and hydraulics, of the heat, ventilation, and general housing requirements of farm animals, and of the heat and ventilation requirements and the behavior as regards spoilage under storage conditions of farm crops. Everything indicates that data is required on these subjects to serve as bases for the development of tillage and traction machinery, farm structures, and drainage and irrigation methods and practices.

The conclusion seems inevitable, therefore, that agricultural engineers must broaden and strengthen their co-operative relations with the other branches of agriculture if they expect to maintain a position of equal scientific and professional standing.

New A. S. A. E. Members

J. H. Boggs, manager, Missouri Gas and Electric Service Company, Richmond, Mo.

W. D. Brinckloe, architect and author, Easton, Md.

J. N. Cadby, executive secretary, Wisconsin Utilities Association, Madison, Wis.

E. C. Curtis, engineer, Kansas Gas and Electric Company, Wichita, Kans.

F. S. Dewey, vice-president, Kansas City Power & Light Company, Kansas City, Mo.

C. O. Dunten, manager, commercial department, Central Illinois Public Service Company, Springfield, Ill.

W. C. Harrington, promotional work, Portland Cement Association, Syracuse, N. Y.

C. R. Higson, assistant to general superintendent, Utah Power & Light Company, Salt Lake City, Utah.

W. H. Horton, Jr., distribution manager, West Penn Power Company, Pittsburgh, Pa.

N. A. Kessler, specialist in agricultural engineering, Northeastern Michigan Development Bureau, Bay City, Mich.

L. A. McArthur, vice-president and general manager, Pacific Power and Light Company, Portland, Ore.

J. F. McCarthy, farm line salesman, Central Illinois Public Service Company, Springfield, Ill.

F. L. Peterson, agricultural and sales promotion engineer, Holt Mfg. Company, Peoria, Ill.

A. L. Teodoro, assistant professor of rural engineering, University of the Philippines, Los Banos, Laguna, P. I.

TRANSFER OF GRADE

H. T. Barr, instructor in agricultural engineering, University of Arkansas, Fayetteville, Ark. (From Student to Junior Member.)

A. L. Burras, department of agricultural engineering, Ohio State University, Columbus, Ohio. (From Student to Junior Member.)

S. P. Lyle, head, department of agricultural engineering, State Agricultural School, Jonesboro, Ark. (From Associate Member to Member.)

L. G. Samsel, Kenesaw, Neb. (From Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to applicants for the consideration of the Council prior to election.

D. C. Angas, wheat farmer, Hill River, Clare, South Australia.

W. A. Forbes, Pacific Coast manager, Potash Importing Corporation of America, San Francisco, Calif.

TRANSFER OF GRADE

U. S. Allison, Bishop, Texas. (From Student to Junior Member.)

M. B. Barnett, McKinney, Texas. (From Student to Junior Member.)

M. A. Bengston, Oakland, Neb. (From Student to Junior Member.)

D. G. Carter, head, department of agricultural engineering, University of Arkansas, Fayetteville, Arkansas. (From Associate Member to Member.)

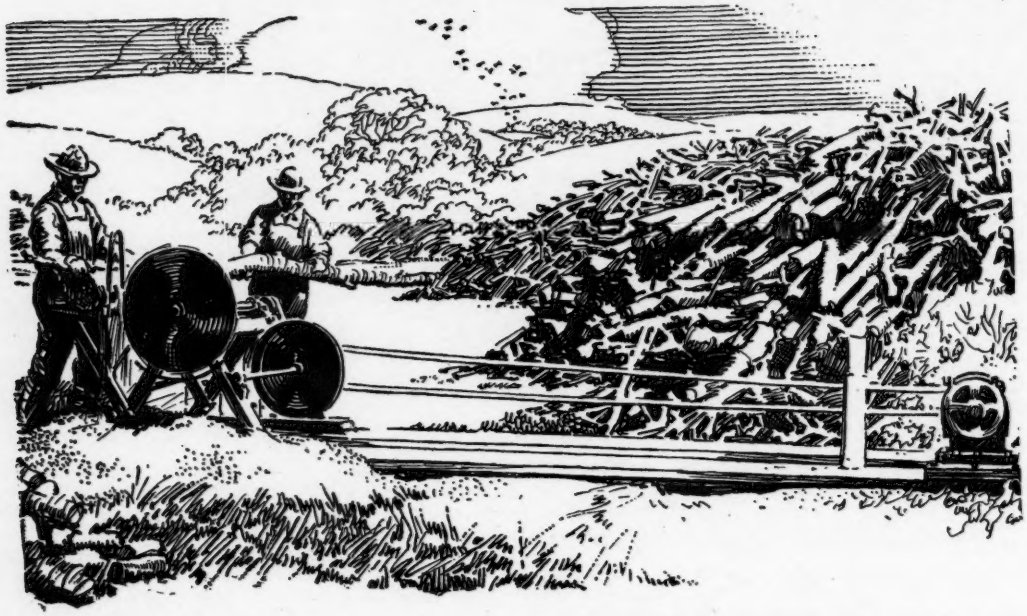
E. H. Gohmert, stock clerk, International Harvester Company, Houston, Texas. (From Student to Junior Grade.)

C. F. Gorman, Winnsboro, Texas. (From Student to Junior Member.)

H. O. Roberts, Jr., Terrell, Texas. (From Student to Junior Member.)

W. H. Willis, Bryan, Texas. (From Student to Junior Member.)

How Agricultural and
are cooperating in



HOW can the problem of electrifying several million farms be solved? The answer has been given by Mr. J. E. Martin in Agricultural Engineering for February, 1923.

"It is not an electrical problem," says Mr. Martin. "It is not an agricultural problem. It is an economic problem that involves both electrical and agricultural problems. The economic problem will not be solved by the electrical industry working independently, nor by the agricultural industry. It must be solved by both working in harmony in order that the viewpoints of both may be properly considered."

A National Committee of agricultural and electrical engineers is attacking this problem along the lines here laid

NATIONAL ELECTRIC

AGRICULTURAL ENGINEERING

Published monthly by the American Society of Agricultural Engineers

at the headquarters of the Society

54 North Avenue, Mount Clemens, Michigan, U. S. A.

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to the members of the Society, $2.00 a year, 20 cents a copy. Postage to Canada, 50 cents additional; to foreign countries, $1.00 additional. Entered as second-class matter, November 7, 1923 at the post office at Mt. Clemens, Michigan, under Act of August 24, 1912. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title "Agricultural Engineering" is registered in the U. S. Patent Office.

H. B. WALKER, President RAYMOND OLNEY, Secretary-Treasurer

Vol. 5 AUGUST, 1924 No. 8

CONTENTS

EDITORIALS....171

HOW FAR SHOULD FARM HOUSES BE STANDARDIZED....172
By W. G. Ward

THE MANLESS PLOW....174
By J. B. Davidson

NEW DEVELOPMENTS IN SALVAGED WAR EXPLOSIVES....175
By W. A. Rowlands

SUMMARY OF THE NATIONAL FARM POWER SURVEY....176
By C. D. Kinsman

RESEARCH METHODS IN AGRICULTURAL ENGINEERING....180
Some Research Features of the Application of Electricity to Agriculture
By R. W. Trullinger

SURVEY OF AGRICULTURAL ENGINEERING PROGRESS....186
By R. W. Trullinger

A. S. A. E. AND RELATED ENGINEERING ACTIVITIES....188

Statements of facts or opinions advanced in original articles, papers or discussions are not sponsored by the Society as a body. Original articles, papers, discussions and reports may be reprinted from this publication provided proper credit is given.

The Object and Scope of A. S. A. E. Activities

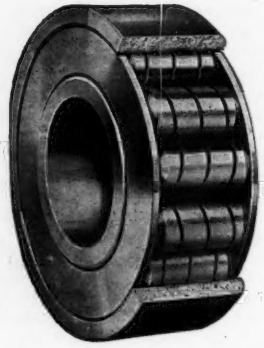
THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.
(b) Farm Structures—buildings and other structures and related equipment.
(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.
(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.
(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.

Member American Engineering Council



There are scores of bearings that lay claim to every known quality and advantage—but what other bearing possesses the record of performance that has been established by Hyatts over the same period of years? To specify Hyatt Roller Bearings is to prove your good judgment.

HYATT ROLLER BEARING CO.

NEWARK DETROIT CHICAGO SAN FRANCISCO

Buffalo Minneapolis Philadelphia
Pittsburgh Cleveland Milwaukee
Huntington Worcester

HYATT

ROLLER BEARINGS